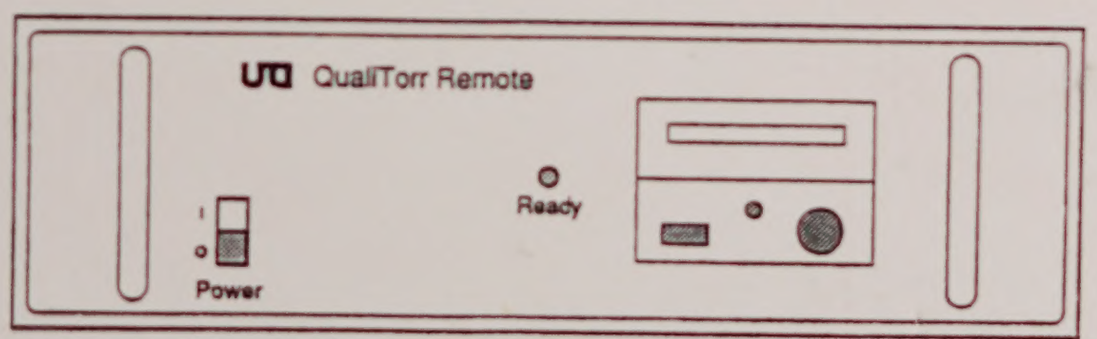
QualiTorr Remote

Installation And Maintenance Manual



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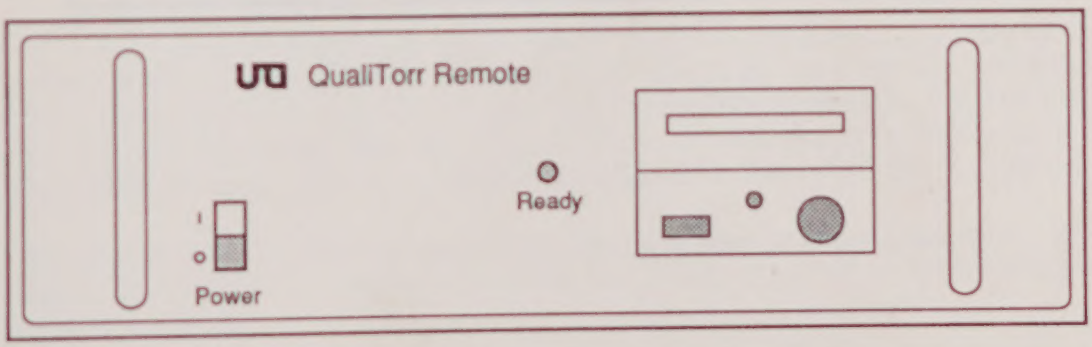

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Hardware and software may be changed without notice. We have made every reasonable effort to ensure the accuracy and completeness of this document; however, we encourage all readers to provide us with suggestions for overall improvement. Please report errors, omissions, or inconsistencies to UTI Customer Support.

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Preface

The QualiTorr Remote System is a quadrupole mass analyzer that provides quantitative process monitoring of gases over the mass range of 1 to 200 AMU. The state-of-the-art electronics uses menu-driven software to assist the user with each step of process gas analysis. The instrument is clean-room compatible and may be used in virtually any process environment. Each Remote Station consists of a Station Probe and a Station Controller.

Each QualiTorr Remote Station Controller houses the power supplies and amplifiers necessary to support one Station Probe to provide one channel of process gas analysis. One to eight QualiTorr Remote Stations can be operated by a single Host Computer UTI's Host Computer utilizes a PC AT with a 80386 microprocessor clocked at 33 MHz.

Startup and Maintenance of the QualiTorr Remote System is conducted in Local Mode without the Host Computer. Normal operation is provided by the UTI Host Computer Mode of operation.

The versatile sampler design (closed ion source) accommodates the quantitative detection of one part per million gas concentration in the presence of process pressures ranging from 4.0 to 10^{-4} Torr (5.32×10^{2} to 1.33×10^{-2} Pa or 5.32 to 1.33×10^{-4} mbar). The UTI Atmospheric Pressure Sampling Module (APSM) extends the quantitative pressure range to accommodate process pressures from 152 to 1520 Torr (2.02×10^{4} to 2.02×10^{5} Pa or 2.02×10^{2} to 2.02×10^{3} mbar).

The instrument can also be used without the sampler (open ion source) to monitor processes in the pressure range from 10^{-5} to 10^{-13} Torr (1.33×10^{-3} to 1.33×10^{-11} Pa or 1.33×10^{-5} to 1.33×10^{-13} mbar).

The UTI Fast Response Sampling Module (FRSM) is used with a single pressure-reduction orifice to provide an extremely close coupling between the gas analyzer and the process chamber to achieve the fastest possible detection response for process pressures greater than 10^{-3} Torr (1.33×10^{-1} Pa or 1.33×10^{-3} mbar). The FRSM accommodates process pressures as high as 4 Torr (532 Pa or 5.32 mbar).

The QualiTorr Remote System can also serve as a sensitive leak detector, and this capability is extended by using a compact hand-held sensor that is available as an optional accessory.

This installation and maintenance manual provides all of the information required to properly install, test, certify, and maintain the QualiTorr Remote. This manual consists of twelve chapters, seven appendices, and an index that are summarized on the next two pages.

Chapter 1 - System Overview: Provides a general introduction to the QualiTorr Remote's functions, features, and a general description of its design, theory of operation, and applications.

Chapter 2 - Specifications: Provides a summary of environmental requirements, site protection, design and performance, power and air requirements, and space requirements.

Chapter 3 - Unpacking: Provides step-by-step instructions on how to properly unpack the QualiTorr Remote's shipping crates. Includes removal of restraints, special considerations for specific components, and tagging conventions for certain parts, as well as preliminary preparation procedures.

Chapter 4 - Installation: Provides the step-by-step installation, checkout, and certification of the QualiTorr Remote. Procedures are supported with referenced drawings and diagrams to clarify the instructions.

Chapter 5 - FRU Removal and Replacement: Provides step-by-step instructions for the removal and replacement of all major Field Replaceable Units (FRUs). Each procedure includes cross-references to printed circuit boards and component assemblies.

Chapter 6 - Adjustments: Provides step-by-step adjustment procedures with complementary drawings and diagrams. The instructions refer to specific alignment and adjustment points that are clearly illustrated.

Chapter 7 - General Maintenance: Provides lists of routine procedures that must be performed to ensure continued trouble-free performance of the QualiTorr Remote. These procedures are grouped in the following categories: Daily, Monthly, Six-Monthly, and Yearly.

Chapter 8 - Computer Maintenance: Describes maintenance procedures for the computers in the Station Controller and Host Computer.

Chapter 9- Theory of Operation: Provides a discussion of the theory of operation and a description of the functions of the primary components.

Chapter 10 - Troubleshooting: Provides a summary of possible problems and their respective solutions using a step-by-step procedural methodology.

Chapter 11 - Parts List: Provides a spare parts breakdown of the Field Replaceable Units (FRUs) referenced to part number and part description.

Chapter 12 - Schematics and Assembly Drawings: Provides a set of schematic diagrams and other related assembly drawings of the QualiTorr Remote's circuitry.

Appendix A - Vacuum System Considerations: Provides a brief introduction to the use of high vacuum systems.

Appendix B - Orifice Selection: Provides a guide to the selection of pressure-reduction orifices.

Appendix C - Using Calibration Gases: Provides an introduction to the calibration of the QualiTorr Remote using only single gases or a single gas and the UTI Cal-Gas mixture.

Appendix D - Local Mode Operating Instructions: Provides QualiTorr Remote Local Mode operating instructions for Maintenance Calibration and for the Process Programmer and Process Operator.

Appendix E - Host Computer Operating Instructions: Provides QualiTorr Remote Host Computer Mode operating instructions for the control and monitoring of one to eight Remote Stations.

Appendix F - Vacuum System Controller: Provides QualiTorr Vacuum System Controller (VSC) installation and operating instuctions.

Appendix G - Glossary: Provides a reference list of QualiTorr Remote terms and definitions.

Appendix H - System Package: Provides system-specific information.

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Safety Summary

This section provides warning and danger statements that identify conditions or practices that could result in personal injury. These statements are repeated throughout the Manual in appropriate sections as a safety reminder to the user. The user is also introduced to Caution statements that point out conditions or practices that could result in damage to the QualiTorr Remote. Caution statements are used throughout the Manual in appropriate sections.

WARNING and DANGER STATEMENTS identify conditions or practices that could result in personal injury.

> **WARNING**
>
> **This instrument uses high voltage. Extreme care should be used when performing maintenance and adjustments while power is On.**

NOTES are used throughout the manual to alert the user to important operating or maintenance procedures.

> NOTE
>
> All notes should be read and understood before proceeding with the next step in any procedure.

CAUTION STATEMENTS point out conditions or practices that could result in damage to the QualiTorr equipment or media.

> **CAUTION**
>
> **The installation and maintenance instructions contained in this manual are for use by qualified personnel only.**

THE LIGHTNING ARROW SYMBOL is intended to alert the user to the presence of un-insulated dangerous voltage within a component's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

FEDERAL COMMUNICATIONS COMMISSION
RADIO FREQUENCY INTERFERENCE STATEMENT

WARNING:
This equipment has been certified to comply with the limits for a Class A computing device, pursuant to Subpart J of Part 15 of FCC rules. Only peripherals (computer input/output devices, terminals, printers, etc.) certified to comply with the Class A limits may be attached to this device. Operation with non-certified peripherals may result in interference to radio and TV reception.

INSTRUCTIONS TO USER:
This equipment generates and uses radio frequency energy and if not installed and used properly, i.e., in strict accordance with the operating instructions, reference manuals, and the service manual, may cause interference to radio or television reception. It has been tested and found to comply with the limits for a class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial installation.

If this equipment does cause interference, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Plug the equipment into a different power outlet so that different branch circuits are utilized.
- Ensure that card mounting screws, attachment connectors screws, and ground wires are tightly secured.
- Ensure that the enclosure panels are installed properly.
- Ensure that proper cable shielding procedures have been utilized.

The manufacturer is not responsible for any interference caused by unauthorized modifications to this equipment. It is the responsibility of the user to correct such interference.

Chapter 1

System Overview

1.1 QualiTorr Remote System Overview

The QualiTorr Remote System is a quadrupole mass analyzer that provides quantitative process monitoring of gases over the mass range of 1 to 200 atomic mass units (AMU). The instrument is sensitive over a dynamic pressure range of eight decades. The resolving power over the complete mass range (M/ΔM) is 2M.

The QualiTorr Remote System user can:

- ❒ Characterize processes and establish standards.
- ❒ Ensure day-to-day consistency by comparing each production run to standards.
- ❒ Ensure process-to-process repeatability and machine-to-machine consistency.
- ❒ Maximize process system up-time by scheduling maintenance based on mass signature comparisons.
- ❒ Define acceptable operating conditions by comparing operating parameters to user-defined tolerance levels.
- ❒ Monitor process progress by use of the keyboard controls and easy-to-read color-coded charts and graphics.

Figure 1-1 summarizes the QualiTorr Remote terminology. A QualiTorr Remote *Station* consists of one *Station Probe* and one QualiTorr Remote *Station Controller*. A *QualiTorr Remote System* consists of one or more QualiTorr Remote Stations and a *Host* Computer.

Each QualiTorr Remote *Station* consists of a *Station Controller* and either an open or closed ion source *Station Probe* with its respective associated hardware. One to eight analysis *Stations* can be operated by a single stand-alone *Host* Computer. UTI's standard QualiTorr Remote System configuration uses a 33 MHz 386 personal computer for the *Host*. OEM *Host* configurations are also supported.

The versatility of the system design allows a QualiTorr Remote System to be configured to meet a wide variety of specific process monitoring requirements by the selection of component options.

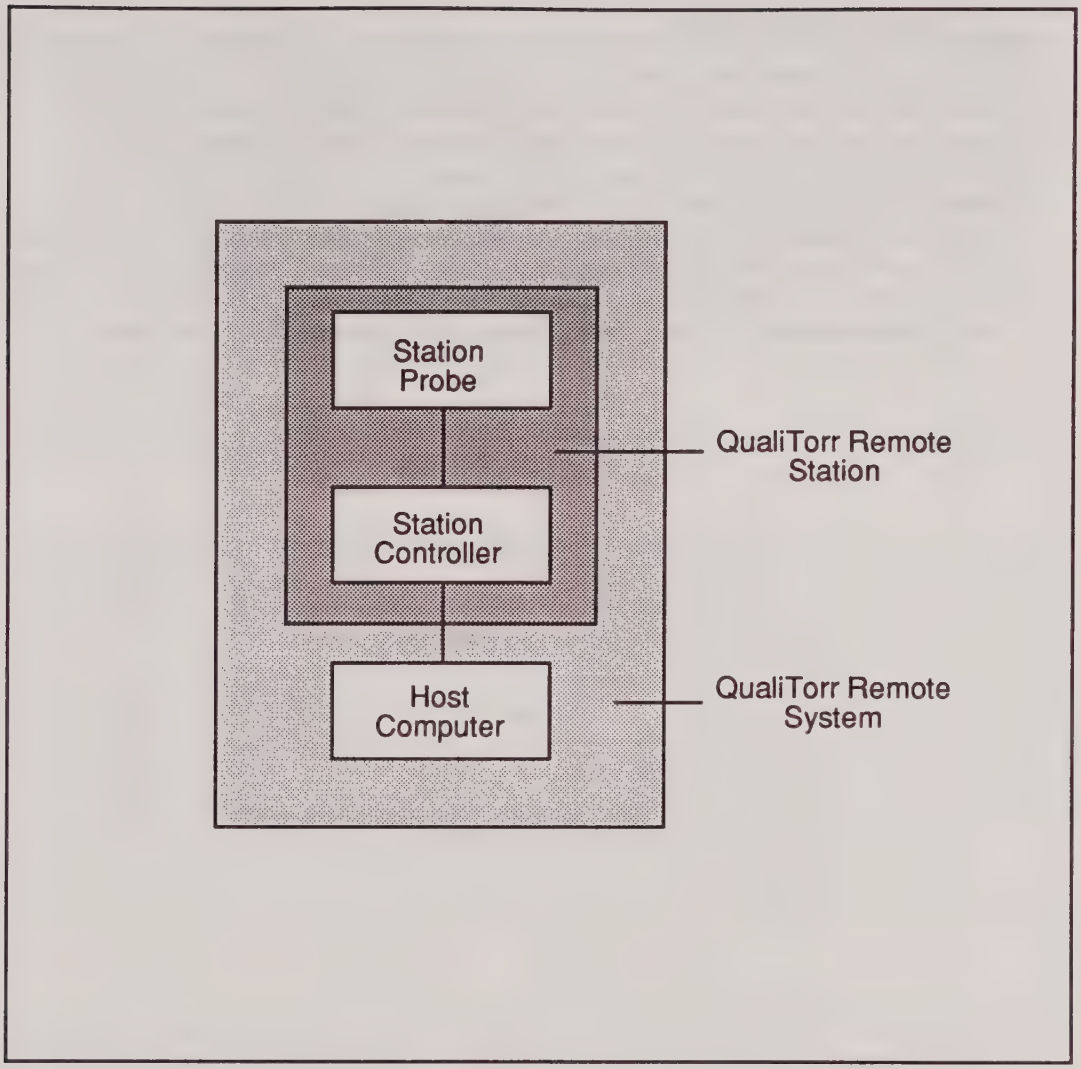


Figure 1-1 QualiTorr Remote Terminology

The *Station Probe* consists of either an open or closed ion source. The open ion source probe is used without a sampler or any additional vacuum pump hardware to monitor processes where operating pressures range from 10^{-5} to 10^{-13} Torr (1.33×10^{-3} to 1.33×10^{-11} Pa or 1.33×10^{-5} to 1.33×10^{-13} mbar). See Section 1.3.

The closed ion source is used with a pressure-reduction sampling module and associated mechanical and turbomolecular pumps. This system configuration allows measurements of parts per million (PPM) gas concentrations while quantitatively monitoring process pressures ranging from 1520 to 10^{-4} Torr (2.02×10^{5} to 1.33×10^{-2} Pa or 2.02×10^{3} to 1.33×10^{-4} mbar). See Section 1.4.

1.2 Station Controller

The *Station Controller* shown in Figure 1-2 houses the power supplies and amplifiers necessary to drive one *Station Probe* and to collect one channel of process gas analysis data. The computer system in the QualiTorr Remote Station Controller consists of an IBM PC AT-compatible 80286 Mother Board, Analog/Digital I/O Board, Disk Drive Controller Board, Serial/Parallel RS-485 Board, Video Graphics Adapter (VGA) Board, and 1.4 MB Floppy Disk. The Station Controller can be run in the normal analyzer operation QualiTorr Remote Station Mode or one of two maintenance Modes. See Chapter 8, *Computer Maintenance*.

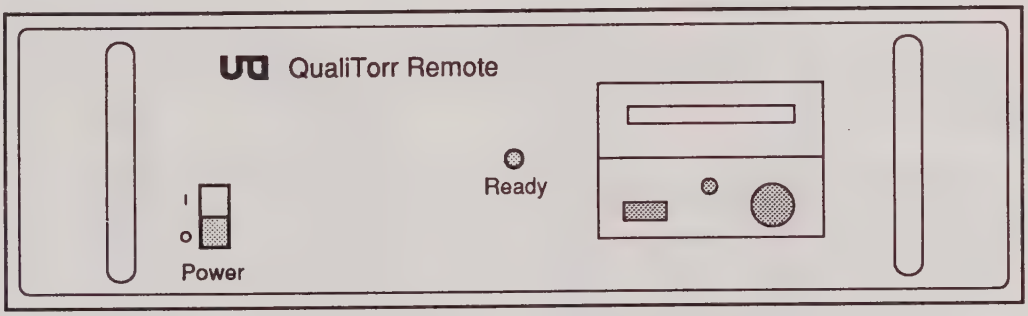


Figure 1-2. QualiTorr Remote Station Controller

1.3 UTI Host Computer

Multiple Station Controllers can be operated by a single stand-alone Host computer. The UTI standard operating configuration uses a 33 MHz 80386 computer with a 40 MB hard drive, 4 MB RAM, 1.44 MB 3.5-inch floppy drive, 14-inch VGA monitor, and keyboard. UTI QualiTorr Remote software runs on the UTI Host Computer under the Disk Operating System (DOS) to provide the user-friendly, simple-to-understand menus that guide the user in logical and efficient manner through all procedures and analyses. Process mass spectra are analyzed and displayed in simple to read color-coded charts and graphs.

The Host Computer's master menu for a four-station QualiTorr Remote System is shown in Figure 1-3. The pull-down menus are shown fully extended to show the functions available under the *System* Menu and each of the Station *Menus*.

UTI Instruments				
System	Station 1	Station 2	Station 3	Station 4
About Quali-Torr Remote	Run	Run	Run	Run
	Stop	Stop	Stop	Stop
Copy Files	New	New	New	New
Delete Files	Open	Open	Open	Open
	Close	Close	Close	Close
Network	Arrange	Arrange	Arrange	Arrange
	Axis	Axis	Axis	Axis
	View	View	View	View
Change Mode	Recipes	Recipes	Recipes	Recipes
Shutdown	Remote Status	Remote Status	Remote Status	Remote Status
	Leak Hunt	Leak Hunt	Leak Hunt	Leak Hunt
	Print	Print	Print	Print

Figure 1-3 Host Computer Master Menu for a Four-Station Remote System

1.3.1 Select *System*

The operator has the option of either selecting *System* or selecting one of the QualiTorr Remote Stations at any time. In *Program Mode*, when *System* is selected, the following functions are displayed for selection: About QualiTorr Remote, Copy Files, Delete Files, Setup, Network, Change Mode, and Shutdown.

1.3.1.1 About QualiTorr Remote

This function displays UTI's copyright notice and the version number of the QualiTorr Remote software. It also includes UTI's address and telephone number.

1.3.1.2 Copy Files

This function allows the user to copy files from the Host Computer hard disk to the Host Computer floppy disk.

1.3.1.3 Delete Files

This function allows the user to delete files on the hard disk.

1.3.1.4 Setup

This function allows the user to specify system-wide parameters for all Remote Stations.

1.3.1.5 Network

This function allows the user to review and select which Remote Stations in the Remote System's Network are Registered and On-Line.

1.3.1.6 Change Mode

The Host Computer can be operated in either *Program Mode* or *Monitor Mode*. *Program Mode* provides the operator with all of the functions and features of the QualiTorr Remote System. The user operating in *Program Mode* can initiate a change from *Program Mode* to *Monitor Mode* at any time by selecting *Change Mode*; this activates the *Monitor to Program Mode Password* dialog box. If the operator wants to limit access to *Program Mode*, the operator can enter a password. If the operator does not want to limit access to *Program Mode*, the operator can choose not to enter a password.

Monitor Mode provides the operator with a limited set of functions and features. The user operating in *Monitor Mode* can initiate a change from *Monitor Mode* to *Program Mode* at any time by selecting *Change Mode*. If a previous operator (see previous paragraph) has set a password to limit access to *Program Mode*, then the operator desiring to enter into Program Mode must know and enter the previously invoked password into the *Monitor to Program Mode Password* dialog box. If the password cannot be correctly entered, then access to *Program Mode* is not permitted.

The Host Computer System boots directly to *Monitor Mode*. If the operator desires access to functions available only in *Program Mode*, then the operator must select *Change Mode*.

1.3.1.7 Shutdown

This function allows the user to shutdown all QualiTorr Remote Stations. All data collection is terminated. All Remote Stations are put into *Idle* status. This function ensures a safe shutdown of all disk I/O operations. *Shutdown* must be selected before turning the Host Computer and/or Station Controller Off.

1.3.2 Select *Station*

The operator has the option of either selecting *System* or selecting one of the QualiTorr Remote *Stations* at any time. In *Program Mode*, when a *Station* is selected, the following functions are displayed for selection: Run, Stop; New, Open, Close; Arrange, Axis, View; Recipes..., Remote Status, and Print. This set of options is available for each active QualiTorr Remote Station. Each Station is controlled and monitored independently of every other Remote Station in the System. The Registered Remote Stations are displayed across the top of the Display's Screen.

1.3.2.1 New/Open/Close

This function allows the user to select parameters to define a *New* scan configuration, to *Open* an existing (pre-defined) scan configuration, or to *Close* a previously defined scan configuration. Analog, Dynamic, or Static Scans may be chosen. Alternatively, Calibration or Leak Hunt functions can be selected. Selection of Open allows the user to view previously defined configuration Serial Numbers, Scan Type, Run Time, and the Title of the configuration.

1.3.2.1.1 Analog Scan

Selecting *Analog Scan* allows the user to select the Name of the Scan, to define the Center (1-200 AMU), Width (1-200 AMU), and to control the Vacuum System Controller by activating Valves 0 1, 2, 3, and/or 4.

1.3.2.1.2 Dynamic Scan

Selecting *Dynamic Scan* allows the user to select the Name of the defined scan configuration, Scan Duration (Minutes), and to control the Vacuum System Controller by activating Valves 0 (no valve), 1, 2, 3, and/or 4. In addition, the user selects the Monitor Mode Setup (display and cycles) by selecting Time Profile, Bar Display, Ratio Time Profile, or Ratio Bar Display. The user also selects Cycles. Either One Scan or Continuous (Circular Buffering) is selected. Finally, the user defines the AMU Setup by selecting the Channel AMUs of interest and specifying the Low Alarm and High Alarm thresholds.

1.3.2.1.3 Static Scan

Selecting *Static Scan* allows the user to select the Name of the defined scan configuration, the AMU Sampling Range (1-200 AMU), the Monitor Mode Setup (display and cycles), the Vacuum System Controller valve status, and the Cycles. Monitor Mode Setup allows selection of either Scan, Scan Reference Overlay, Scan Reference Ratio, or Scan Reference Subtraction. The Vacuum System Controller's valves (1-4) are either activated or unactivated and Cycles are chosen to be either Single Scan, Continuous (Circular Buffering) or Scan and Save for [specified number] of minutes.

1.3.2.1.4 Calibration

Selecting *Calibration* allows the user to specify the Calibration Gas, the Dynamic Operating Range, and the Vacuum System Controller configuration. The Calibration Gas can be either UTI Calibration Gas, Nitrogen, Argon, CHF_3, C_2F_6, or Custom Calibration Gas. The Dynamic Operating Range is determined by user specification of the Maximum Operating Pressure of the Station, setting the pressure of the Cal Gas, and specifying the Gauge Pressure of the Cal Gas.

1.3.2.1.5 Leak Hunt

Selecting *Leak* Hunt allows the operator to search for system leaks. Select a leak-hunt gas, then apply the gas to the exterior of the vacuum system to detect the gas using the relative pressure indications displayed on the system monitor. The optional hand-held Leak Hunter on a cable can also be used. See Figure 6-17. The Leak Hunter is connected to the front of the Remote Station Controller.

1.3.2.2 Run/Stop

Selecting *Run* in *Program Mode* allows the operator to view and select Recipes that have been previously selected in *Program Mode*. When selected, the scan defined by the Recipe selected is initiated with an OK (Enter). Selecting *Run* in *Monitor Mode* allows the operator to view and select Recipes that have been previously selected in *Program Mode*. When selected, the scan defined by the Recipe selected is initiated with an OK (Enter).

Selecting *Stop* terminates a scan.

1.3.2.3 Arrange/Axis/View

Selecting *Arrange* allows presentations of graphs as full, half, or quarter screens.

Selecting *Axis* allows the operator to change the Y axis on Analog and Static Scans. Selecting Axis for Dynamic Scans allows the operator to change the X and Y axes. X axis functions include *Zoom In* and *Zoom Out* (in 2x increments), page to the left or to the right, and page to the start or end of a scan. The operator can also manually enter the *Start Time* and *Page Width*. During Dynamic Scan data collection, the data collection display page moves as each page is filled and the operator has access to a *Resume Collection Display Button*.

Selecting *View* allows the operator to view a graph or table when not running a scan. During Dynamic scans, the user can toggle between bar and time profile graphs, but tables cannot be viewed while running.

1.3.2.4 Recipes.../Remote Status/Print

Selecting *Recipes*... allows the operator in *Program Mode* to Add or Remove Recipes. These Scan Recipes are selected from Data Files created by use of the *New* function.

Selecting *Remote Status* allows the operator to select the voltage on the Electron Multiplier and to turn the Filaments On and Off.

Selecting *Print* allows the user to select the following options prior to printing: Next, Previous, Zoom, Setup, Margins, and Close. *Next* displays the next page of data to be printed. *Previous* displays the previous page of data to be printed. *Zoom* enlarges the data to be printed and allows the data to be positioned horizontally and vertically with or without gridlines. *Setup* allows input of header, footer, row, and column headings. When all print parameters are correct, the user selects *Close* to end the printer formatting session.

1.4 Additional Functions and Features

- ❒ Data are displayed accurately in absolute Torr values.
- ❒ Tolerance windows are user defined.
- ❒ The partial pressure of up to ten user-selected gases are displayed in color-coded graphs and bar charts.
- ❒ Known gases may be identified by name or by AMU number.
- ❒ Alarms and graphics indicate out-of-tolerance conditions.
- ❒ Disk drives provide program and data storage for logging, archiving, and historical diagnoses.
- ❒ Eight decade dynamic range.
- ❒ Linearity over five decades.
- ❒ Unmatched stability and repeatability.
- ❒ Unique sampling with sub-ppm detection.
- ❒ Menu-driven software with auto-boot, automatic absolute calibration, static and dynamic X-Y Zoom features selectable static scan with Log/Lin display, static compare with relative deviation, user-defined recipes, and alarm outputs.
- ❒ Compatible with other scientific or process monitoring software.
- ❒ Can be operated by an OEM Host Computer.
- ❒ Parallel operation of up to eight totally independent probes of open and/or closed configuration.

1.5 Open Ion Source Probe

The open ion source probe is used for process monitoring in which the total system pressure monitored ranges from 10^{-5} to 10^{-13} Torr (1.33 x 10^{-3} to 1.33 x 10^{-11} Pa or 1.33 x 10^{-5} to 1.33 x 10^{-13} mbar).

The probe with its RF electronics module is attached directly to the process station using a 2.75-inch Conflat flange. This so-called "nude probe" configuration does not require any auxiliary mechanical or turbomolecular pump vacuum hardware. The RF module is attached to the Station Controller by a 10- to 100-foot cable. The QualiTorr Remote System used in an open ion source probe configuration is shown schematically in Figure 1-4.

Where trace level determination of background process gases is not required, the open ion source probe can be used with a sampler to extend its upper pressure range to as high as 4 Torr.

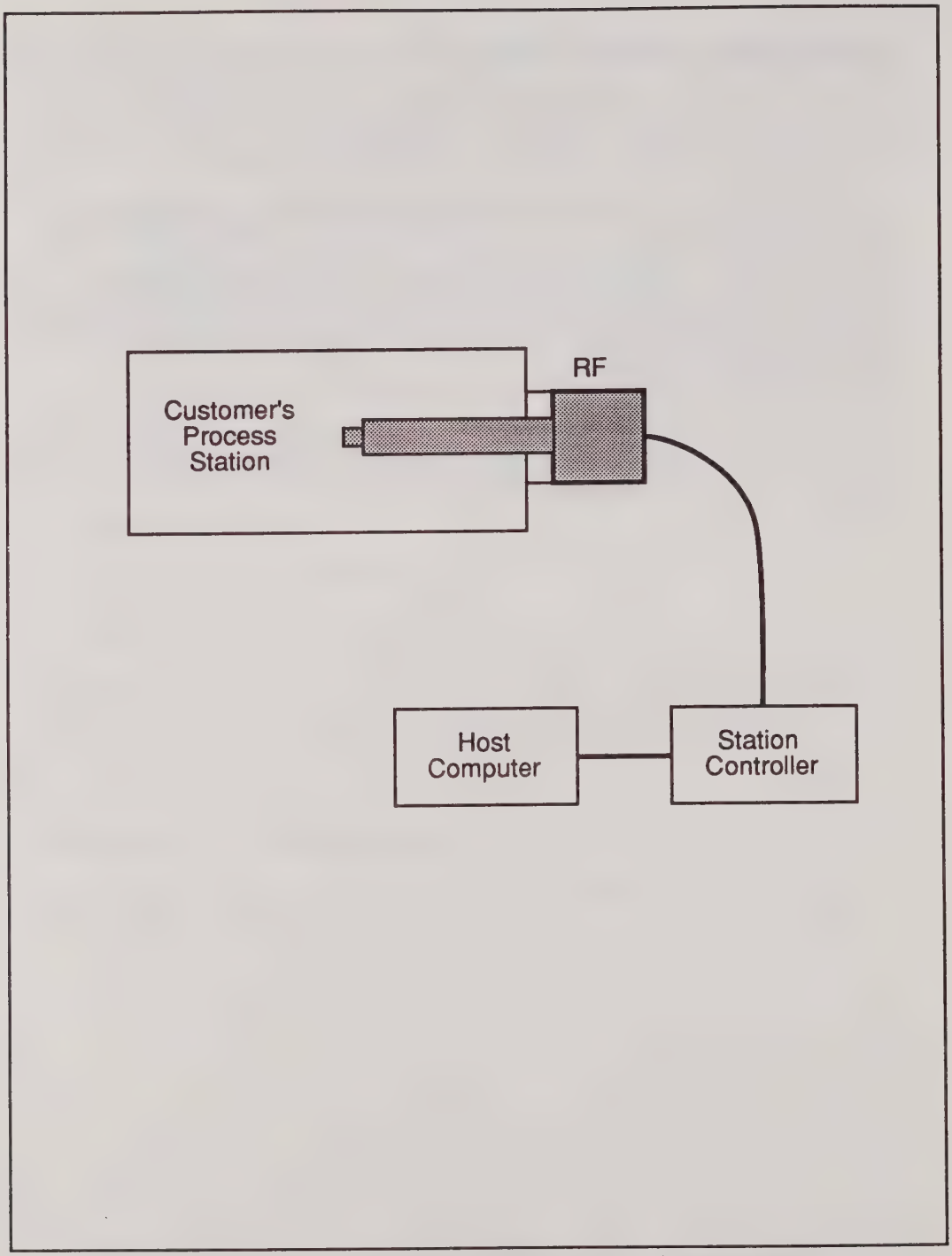


Figure 1-4. Open Ion Source Remote Station Probe Configuration

1.6 Closed Ion Source Probe

The closed ion source probe is used for quantitative process monitoring in which the total pressure of the process may range from 1520 to 10^{-4} Torr (2.02×10^{5} to 1.33×10^{-2} Pa or 2.02×10^{3} to 1.33×10^{-4} mbar).

The closed probe is used with a pressure sampling module that reduces the process chamber pressure so that the pressure at the closed probe is close to its optimum detection pressure of 10^{-3} to 10^{-4} Torr. If the pressure in the process chamber is 1 Torr, the pressure must be reduced by a factor ranging from 10^{-3} to 10^{-4}. If the pressure in the process chamber is 0.1 Torr, the pressure must be reduced by a factor ranging from 10^{-2} to 10^{-3}, and so forth. This pressure reduction is achieved by the use of a sampling module with control valves and small aperture orifices.

The pressure sampling module attaches to any process station to be monitored by use of a 2.75-inch Conflat flange. The closed ion source probe with the RF module attaches to the other end of the manifold using a 4.5-inch Conflat flange. The RF module is attached to the Station Controller. The third side of the T-shaped manifold connects to the turbomolecular pump using a 4.5-inch Conflat flange which is in turn connected to a mechanical pump to provide an auxiliary vacuum system. One version of a sampling module (3PSM) with the QualiTorr Remote System closed ion source probe configuration is shown in Figure 1-5.

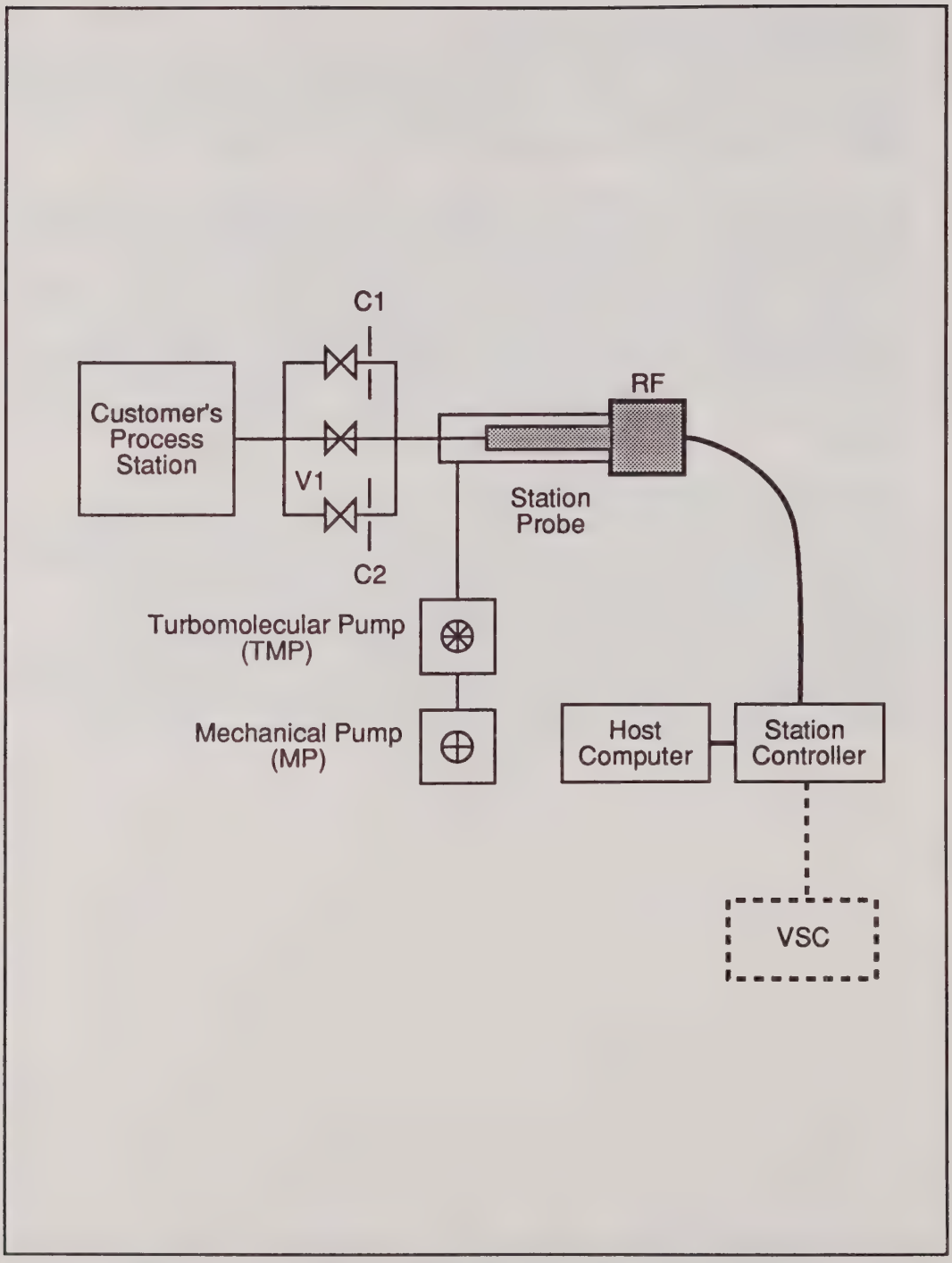


Figure 1-5. Closed Ion Source Remote Station Probe Configuration with Optional VSC (3PSM Version Shown)

1.6.1 Sampling Modules

The various sampling modules are designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 1520 to 10^{-4} Torr (2.02×10^{5} to 1.33×10^{-2} Pa or 2.02×10^{3} to 1.33×10^{-4} mbar). No single sampling inlet can cover this complete total pressure dynamic range of 8 decades, but various combinations are available to meet most applications.

The pressure is reduced by the sampling module so that the pressure in the closed source of the probe ranges from 10^{-3} to 10^{-4} Torr (1.33×10^{-1} to 1.33×10^{-2} Pa or 1.33×10^{-3} to 1.33×10^{-4} mbar). This is accomplished by routing the process gas through a flow restricting path called an orifice. The amount of pressure reduction can be selected to match the process pressure by selecting the proper orifice (hole) diameter. Sampling modules are available to quickly and efficiently accommodate one or more processes that require one, two, three, or four different process pressures. These pressure requirements are accommodated by the 1PSM, 2PSM, 3PSM, 4PSM, APSM, and FRSM pressure-reduction sampling modules. For additional information concerning orifice size selection, see Appendix B.

1.6.1.1 One-Pressure Sampling Module (1PSM)

The 1PSM valve configuration provides a high conductance valve. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor a single decade of process pressure out of the total range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

1.6.1.2 Two-Pressure Sampling Module (2PSM)

The 2PSM valve configuration, shown in Figure 1-6, provides a single orifice for pressure reduction to the closed ion source and a high conductance valve to monitor low pressure processes. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor two different decades of process pressures out of the total range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

1.6.1.3 Three-Pressure Sampling Module (3PSM)

The 3PSM valve configuration, shown in Figure 1-7, provides two valved orifices for pressure reduction to the closed ion source. The high conductance valve provides the ability to also monitor a low pressure process. These three selectable pressure regions are independent and their operating conditions may, therefore, differ considerably from each other. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor three different decades of process pressures out of the total range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

1.6.1.4 Four-Pressure Sampling Module (4PSM)

The 4PSM valve configuration provides three valved orifices for pressure reduction to the closed ion source. The high conductance valve provides the ability to monitor a low pressure process. These four selectable pressure regions are independent and their operating conditions may, therefore, differ considerably from each other. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor four different decades of process pressure out of the total range from 10 to 10^{-3} Torr (1.33 x 10^{3} to 1.33 x 10^{-1} Pa or 13.3 to 1.33 x 10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

1.6.1.5 Atmospheric Pressure Sampling Module (APSM)

The APSM configuration, shown in Figure 1-7, extends the pressure range accessible with the 1PSM, 2PSM, 3PSM, and 4PSM valve configurations to accommodate pressures greater than 10 Torr. This sampling module provides for linear sampling over one decade of pressure while maintaining compositional integrity. This module is a pressure-reduction sampling system that reduces sample process sample pressures from 152 to 1520 Torr (2.02 x 10^{4} to 2.02 x 10^{5} Pa or 2.02 x 10^{2} to 2.02 x 10^{3} mbar) to the working range of the closed ion source probe. Two pressure-reduction stages are used to maintain the integrity of the original sample composition while sampling high process chamber pressures. The APSM can be configured for only one process gas pressure at a time. However, the single pressure-reduction set of two orifices can easily be changed to accommodate other process pressures.

1.6.1.6 Fast Response Sampling Module (FRSM)

The FRSM configuration provides the closest possible coupling between the gas analyzer and the process chamber. This geometry optimizes the sensitivity and response of the special fast response ion source probe that combines the functions of both the probe and a single orifice pressure reduction stage. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor a single decade of process pressures in the range from 10 to 10^{-3} Torr (1.33 x 10^{3} to 1.33 x 10^{-1} Pa or 13.3 to 1.33 x 10^{-3} mbar).

1.6.2 Vacuum Systems

The sampling module requires its own dedicated vacuum system to assist in achieving the pressure reduction between the monitored process and the closed ion source probe. The vacuum system consists of a turbomolecular pump (TMP) and a mechanical pump (MP). The TMP mounts directly to the sampling module using a Conflat flange. The MP is a separate unit. A molecular sieve trap is located between the TMP and the MP to prevent pump oil from entering the vacuum system. The MP is connected to the side of the TMP by a metal vacuum hose. An in-line ball valve attaches between the molecular sieve trap and the metal hose and allows the MP to be isolated from the TMP and probe. The TMP requires a separate electronic drive and power supply to control and monitor pump operation. Some of these units provide front-panel controls for turning the pump on and off and for heating a TMP heating mantle during bakeout. The turbine rotation speed and the cumulative operating hours of the pump are displayed on some models.

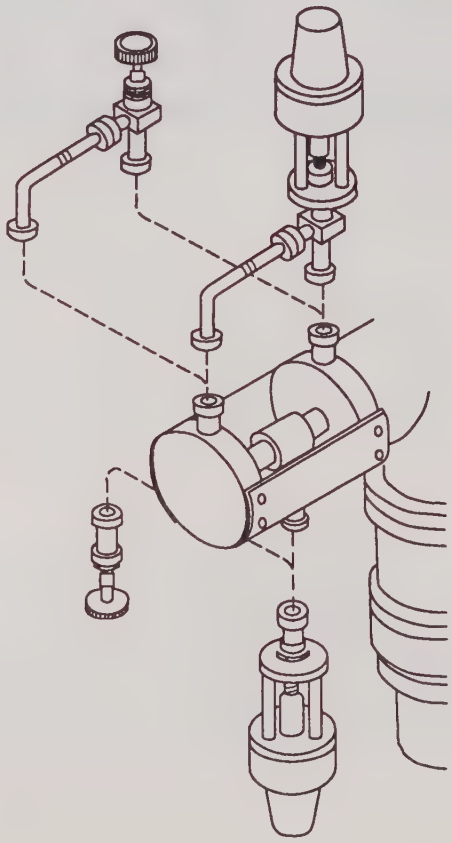


Figure 1-6. A Two-Pressure Sampling Module (2PSM)

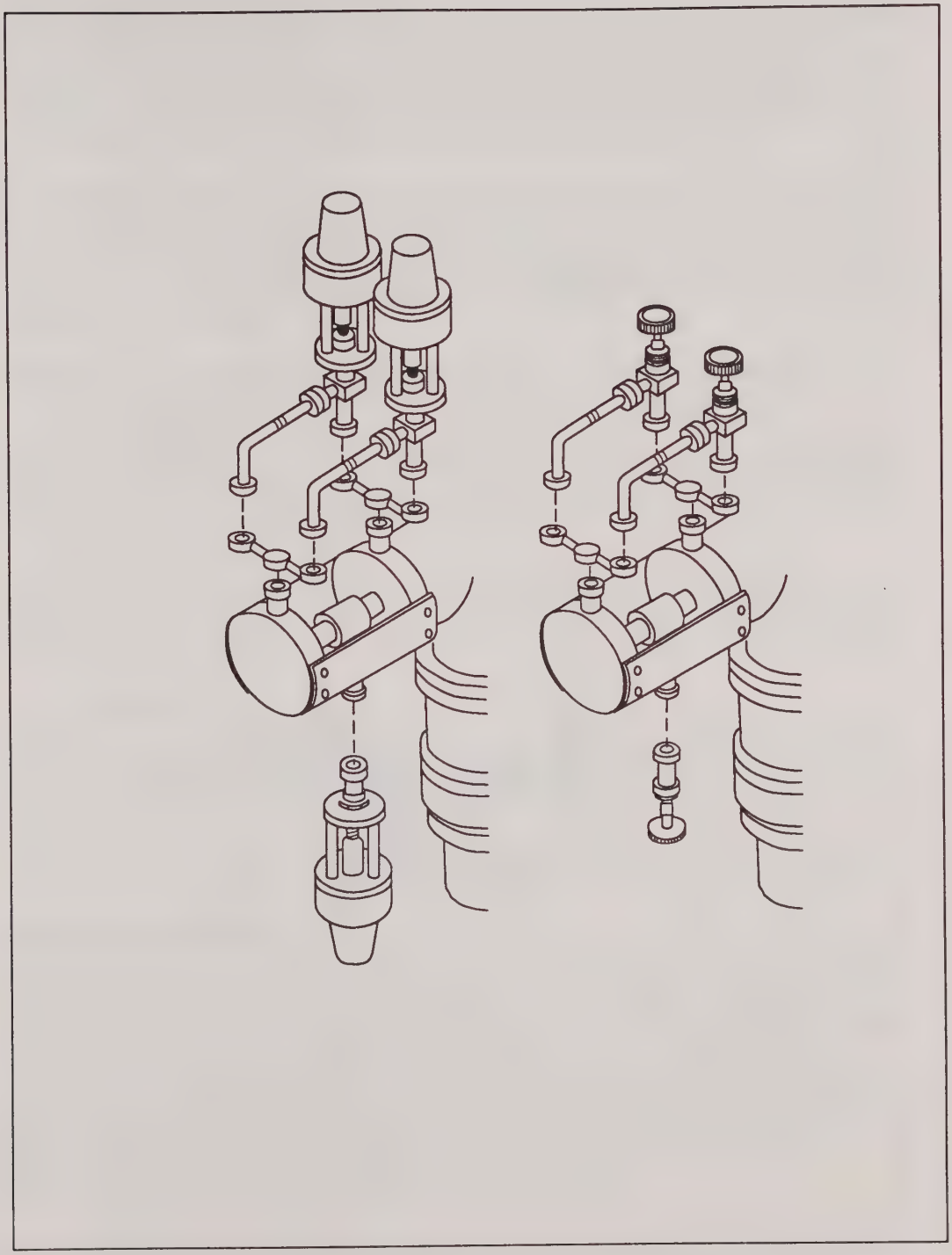


Figure 1-7. A Three-Pressure Sampling Module (3PSM)

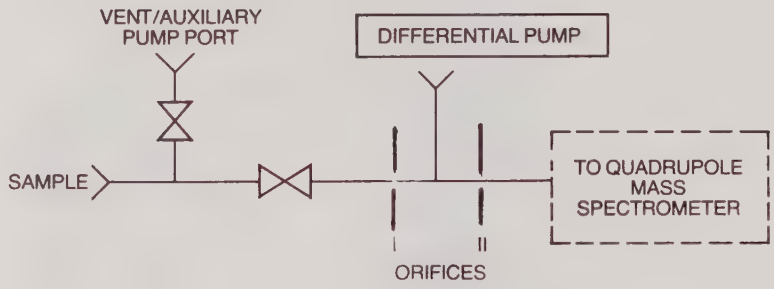


Figure 1-8. The Atmospheric Pressure Sampling Module (APSM)

1.6.2.1 Turbomolecular Pumps

The QualiTorr Remote provides three options for the turbomolecular pump (TMP) corresponding to three pumping speeds — 60, 80, and 240 liters per second. The choice of TMP types is entirely dependent upon the pressures that are to be monitored and the discretion of the user. However, any of these TMPs will provide suitable pumping speed to cover the full operational range of process chamber pressures.

The 60 liter per second TMP, Balzers Model TPU 060 may be controlled and powered by the Balzers Model TCP 121 electronic drive unit and power supply or the UTI Vacuum System Controller (VSC) that utilizes the Balzers Model TCP 120 Electronic Drive Unit. The TPU 060 turns at a nominal speed of 90,000 RPM to achieve an ultimate pressure of 0.75×10^{-9} Torr (1.00×10^{-7} Pa or 1.00×10^{-9} mbar). Either the air or water cooling option is selected when ordering.

The 60 liter per second TMP cannot be "Fomblinized." The TMP's lubricating system does **not** require this special oil when used with hazardous or toxic applications.

The 80 liter per second TMP, Alcatel Model 5080UHV, may be controlled and powered by the Alcatel CFF100 electronic drive unit. The Model 5080UHV turns at a nominal speed of 27,000 RPM to achieve an ultimate pressure of 3.75×10^{-9} Torr (5.00×10^{-7} Pa or 5.00×10^{-9} mbar). Only air cooling is available.

The 240 liter per second TMP, Balzers Model TPU 240, may be controlled and powered by the Balzers Model TCP 121 electronic drive unit and power supply or the VSC that utilizes the Balzers Model TCP 120 Electronic Drive Unit.

1.6.2.2 Mechanical Pump

The Alcatel Model 2004B MP has a pumping speed of 3.2 CFM and is recommended for use with the 60 liter-per-second Balzers Model TPU 060, the 80 liter-per-second Alcatel Model 5080UHV TMP, or the 240 liter-per-second Balzers Model TPU 240 TMP.

For hazardous or toxic applications, it is necessary for the Model 2004B to use Fomblin oil.

1.6.2.3 Heating Mantles

Heating mantles are positioned around the sampling module inlet valves and the probe manifold and are used to heat the metal manifolds while the vacuum system is on to assist in evaporating and pumping out residual contaminant substances such as water and grease that adhere to the internal metal surfaces and cause a high residual contamination pressure that is detected by the sensitive probe. A bakeout heater is also provided with the molecular sieve trap on the top of the MP to periodically remove pump oil, water and other contaminants to maintain a clean vacuum system. A bakeout heater is also provided on the TMP. UTI custom designed mantles (as opposed to heating tapes) typically are thermostatically controlled at 150°C.

1.7 Hardware Options

The QualiTorr Remote System modular design has a wide variety of optional accessories to optimize the convenience and utility of the instrument. These are listed here for your convenience. Call your QualiTorr Remote Sales representative for additional information.

- ❒ **Vacuum System Controller (VSC)**
  This component provides the ability to control and display operating pressures from high vacuum to atmospheric through three Convectron gauges for protection against excessive inlet or foreline pressures; auto turbo turn-off; and auto vent-valve action. Filament protection against accidental venting or over pressure is interfaced to the VSC through a user-supplied signal (user specified voltage). The interlock features deactivate the pneumatic valves (pneumatic-valve option required) via a remote control port on the QualiTorr Remote Station Controller. Controls are also provided for pneumatic-valve operation, pump turn-on (turbo, mechanical, and mechanical), and heating mantles. The 25' cables from the sampling system are included.

- ❒ **Hand-Held Leak Detector**
  This accessory, with its 20' cable, provides convenient remote leak hunting. A compact light bar and variable-pitch audio signal are activated when a leak is detected. Threshold values can be set on the leak detector to adjust for changing background levels.

- ❒ **Electronic Clean Room Cart**
  This cart (20"W x 28"L x 51"H) houses all electronic components associated with the QualiTorr Remote (VSC, QualiTorr Remote Station Controller, and printer.

- ❒ **System Clean Room Cart**
  This cart (30"W x 28"L x 51"H), with its adjustable outrigger, houses all electronic components and provides a complete sampling station. All system hardware including pumps and QualiTorr Remote options are installed. This cart is designed to be used in a clean room environment and has a minimum enclosed volume.

- ❒ **Gas Calibration Bottle**
  This gas cylinder contains a mixture of gases. These gases are referred to as the "UTI Cal Gas"). The mixture contains 1% each of H_2, He, Ar, Kr, Xe, and 95% N_2.

- ❒ **Gas Calibration System**
  This kit consists of the UTI Cal Gas (see above), a two-stage regulator, two nupro valves, a flow control valve, and hardware for a system interface to the user's process.

- ❒ **Pneumatic Multiplier**
  This device attaches to a nitrogen source at 60 psi (minimum) to 80 psi (maximum) and provides nitrogen pressure at 110 to 120 psi. This output pressure is suitable for activation of QualiTorr pneumatic valves.

- **Cart Mounted Gas Calibration System**
  This kit consists of the UTI Cal Gas (see above), a two-wheel hand-truck style cart, and a 3.2 CFM Mechanical Pump. In addition, a two-stage regulator, two nupro valves, a Vat-flow control valve are all mounted in an enclosed cabinet. The system includes a digital Convectron gauge and Cal Gas hardware for system interface to the user's process.

- **Nitrogen Gas Purge System**
  This system includes a nitrogen (N_2) gas bottle (cart mounted if system cart option is purchased) and a gas regulator. A 110 PSI gas regulator for pneumatic valve operation is also included if pneumatic-valve operation is purchased.

- **Color Printer**
  This dot matrix color printer provides hard copy of data tables, spectra, and time profiles. The color printer uses the parallel ports on the Host Computer or Station Controller.

- **Color Video Printer**
  This video printer has the ability to capture and print graphic images in full VGA resolution and color. This option requires the Video Tap option described below and can only be used with the Host Computer.

- **Video Tap**
  This option allows the QualiTorr Host Computer to use a second remote monitor or a video printer. The VGA Tap provides a second VGA port. This is a factory-installed option. The Video Tap provides a Video Distribution Amplifier and all necessary cables.

- **Scan Box**
  The UTI Scan Box is used to conduct electronic adjustments of the QualiTorr Remote to ensure optimum performance.

- **Analog Output**
  This software allows the QualiTorr Remote, when operating in the SPM mode, to provide a 0.10 to 10 volt analog signal at the rear panel of the QualiTorr Remote Station Controller. This analog voltage is proportional to the signal of the first six user-defined channels. Each channel has its own analog output signal.

1.8 Software Options

The QualiTorr Remote has a wide variety of software options to optimize the convenience and utility of the instrument. These are listed here for your convenience. See your QualiTorr Remote Sales representative for additional information.

- **Red-Ball Alarm**
  This software supplies a 0-5 VDC TTL-level signal to the back panel of the QualiTorr Remote Console if any of the 10 user-selected peaks in the SPM mode are out of tolerance. The output drivers are factory configured for active-HI or active-LO operation. The user must specify the driver configuration.

- **Remote Control of VSC**
  This software allows all of the functions of the VSC to be remotely monitored and controlled from the QualiTorr Remote Host's VGA color monitor. Filaments, valves, and pumps can be monitored and controlled. This option must be purchased with pneumatic valves and the Vacuum System Controller (VSC).

- **Fast Scan Software**
  This software increases the scanning speed of the QualiTorr Remote while monitoring up to 10 user-selected peaks in SPM mode. The scanning rate is increased to three samples per second.

Chapter 2

Specifications

This chapter provides the specifications and site requirements that apply to the QualiTorr Remote System components. These include environmental (site) requirements as well as design specifications and performance specifications.

2.1 Environment

The following sections describe the site requirements and environmental specifications that must be observed for reliable system operation.

2.1.1 Temperature and Humidity

Temperature cycling and thermal gradients can include changes in materials that will affect the performance of the system. High temperatures also increase the rate of deterioration of materials. Low humidity can produce static electricity, resulting in dust accumulation on disk devices which may adversely affect the operation of the drives.

The temperature and humidity specifications for the QualiTorr Remote System represent the recommended operating temperature range. For maximum system reliability, the QualiTorr Remote System should be operated within the specifications given in Table 2-1.

Table 2-1. Temperature and Humidity Specifications

Ambient temperatures: 50 to 83 °F (10 to 28 °C)
Shipping temperature: -10 to +150 °F (-23 to 65 °C)
Operating humidity: 10% to 90% with no condensation

2.1.2 Static Electricity

The QualiTorr Remote System components must be adequately grounded to prevent static electricity interference during equipment operation. Any static charges generated can be reduced by ensuring that the relative humidity is moderate. When raised floors are used at the QualiTorr Remote System installation, the metal framing of the floor panels should be adequately grounded. If carpets are used, they should by anti-static.

2.1.3 AC Power Requirements

The QualiTorr Remote System configured for an open source probe requires only AC power for the Station Controller, Host Computer, and peripherals.

The Station Controller requires a power source that provides 5 A using 100, 120, or 140 VAC or 3 A using 200, 220, or 240 VAC. One outlet is required. A switch on the back panel is used to select the voltage to be used.

The UTI Host Computer requires a power source that provides 3 A using 100, 120, or 140 VAC or 1.5 A using 200, 220, or 240 VAC. One outlet is required. A switch on the back panel is used to select the voltage to be used.

The QualiTorr Remote System configured for a closed source probe requires power for the Station Controller, Host Computer, mechanical pump, turbomolecular pump, TMP power supply/control unit, two bakeout mantles, and one molecular sieve heater. The total AC power requirement for the closed source configuration using a power source providing 100, 120, or 140 VAC with the 3.2 CFM mechanical pump is approximately 18 A. The total AC power requirement for the closed source configuration using a power source providing 200, 220, or 240 VAC with the 3.2 CFM mechanical pump is approximately 11 A.

The maximum power consumption occurs during a system bakeout with all heaters On. Multiple outlets are required if the optional Vacuum System Controller (VSC) is not used. Table 2-2 summarizes the power requirements for each of the QualiTorr Remote System components.

Table 2-2. Power Requirement for QualiTorr Remote System components

Component	110-120 VAC 50-60 Hz	200-240 VAC 50-60 Hz
Station Controller	3 A	1.5 A
UTI Host Computer	2 A	1.0 A
VGA Monitor	1.3 A	-
Mechanical Pump		
3.2 CFM (0.37 Kw)	3.4 A	1.7 A
Turbomolecular Pumps		
Power Supply/Controller		
TCP 120	1.5 A	0.9 A
TCP 121	1.5 A	0.9 A
CFF 100	0.6 A	0.3 A
Bakeout Heaters		
Inlet Valve Mantle	2.7 A	1.6 A
Probe Mantle	2.7 A	1.6 A
Molecular Sieve (MP)	2.7 A	1.6 A
Turbomolecular Pump (TMP)	0.28 A	0.14 A
Air Cooling for TMP	0.5 A	0.3 A

2.1.4 Turbomolecular Pump Cooling Water

The turbomolecular pumps must be cooled with either water or air. The standard model uses Air Cooling. If the TMP is to be cooled by water, the installation site must provide a constant flow rate of 15 liters per hour of clean water with a temperature of approximately 15 °C whenever the TMP is running. The Alcatel Model 5081UHV and the Balzers Models TPU 060 and TPU 240 come with a cooling fan as standard equipment.

2.1.5 Pneumatic Actuator Gas

If one or more pneumatic-actuated valves are selected as the means of valve control for the sampling manifold, the installation site must provide a source of actuator gas (dry air or nitrogen gas bottle) fitted with a regulator and connection fittings to provide 110 pounds per square inch (PSI) of pressure to the valve. The regulator should have a gauge that reads up to 200 PSI. A Pneumatic Multiplier (described in Section 1.7) can be used in place of the gas bottle and regulator system.

2.1.6 Purging Gas

A purging or so called "zero gas" is desirable at the installation site to assist in sweeping contaminants from the sampling module and probe. Research grade or high purity nitrogen, helium, or argon having a nominal 99.9999 percent purity and specified to be hydrocarbon-free is suitable.

2.1.7 Space Requirements

A scaled layout of the QualiTorr Remote System component installation can be prepared to determine the exact space requirements. A minimum three-foot clearance should be allowed on all sides of the sampling module attached to the process chamber and the color display console for operator access and servicing. A minimum one-foot clearance should be maintained around the mechanical pump for proper air flow and cooling. The physical dimensions of the QualiTorr Remote System components are given in both English and metric units in the following figures:

Station Controller: See Figure 2-1.

UTI Host Computer: See Figure 2-2.

3PSM Sampling Module: See Figure 2-3.

Mechanical Pump (3.2 CFM), Alcatel Model 2004B: See Figure 2-4.

Turbomolecular Pump, Balzers Model TPU 060 (60 l/s): See Figure 2-5.

Turbomolecular Pump, Alcatel Model 5081UHV (80 l/s): See Figure 2-6.

Turbomolecular Pump, Balzers Model TPU 240 (240 l/s): See Figure 2-7.

TMP Electronic Controller, Balzers Model TCP 120: See Figure 2-8.

TMP Electronic Controller, Balzers Model TCP 121: See Figure 2-9.

TMP Electronic Controller, Alcatel Model CFF100: See Figure 2-10.

Short Probe Configurations: See Figure 2-11.

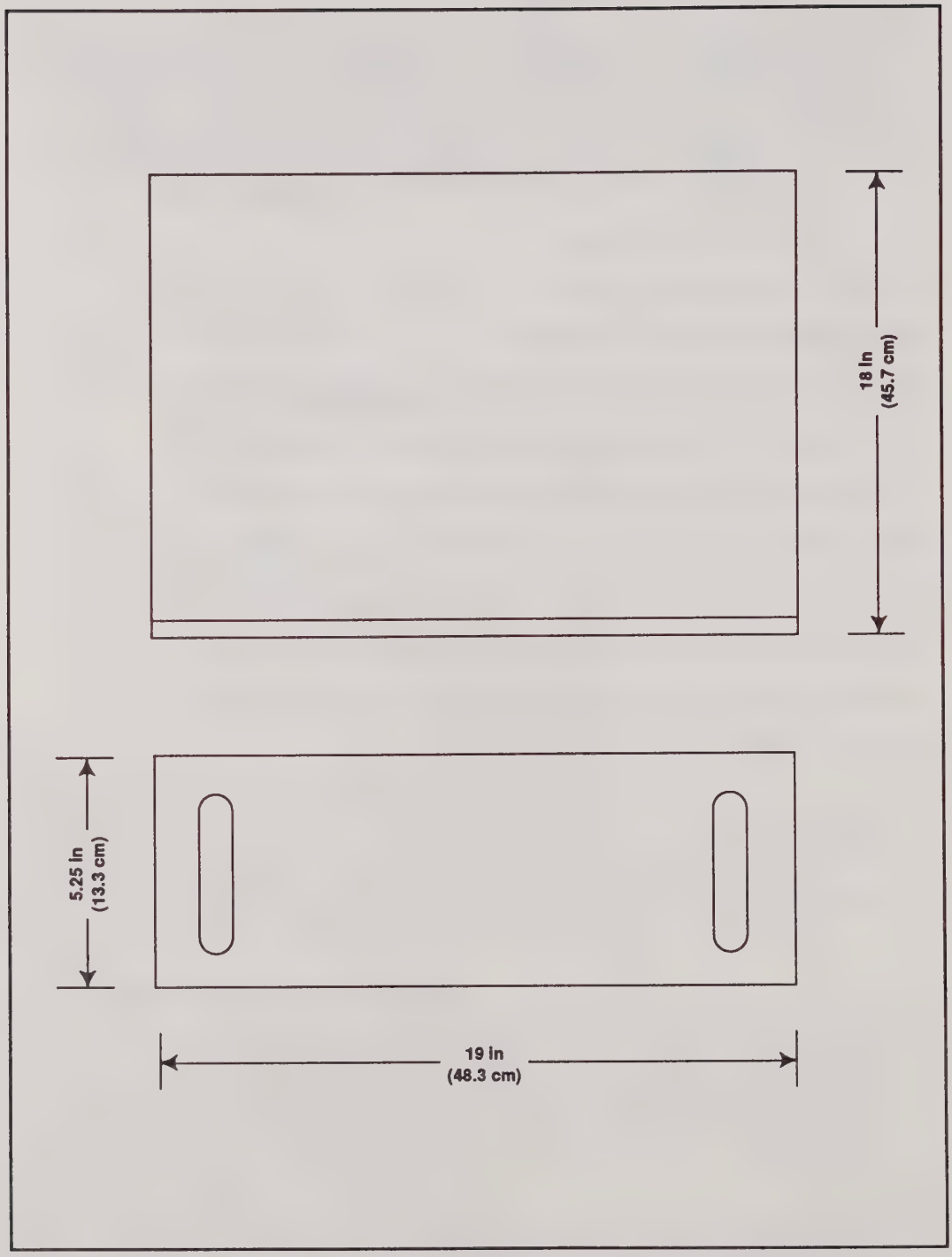


Figure 2-1. Dimensions of the Station Controller

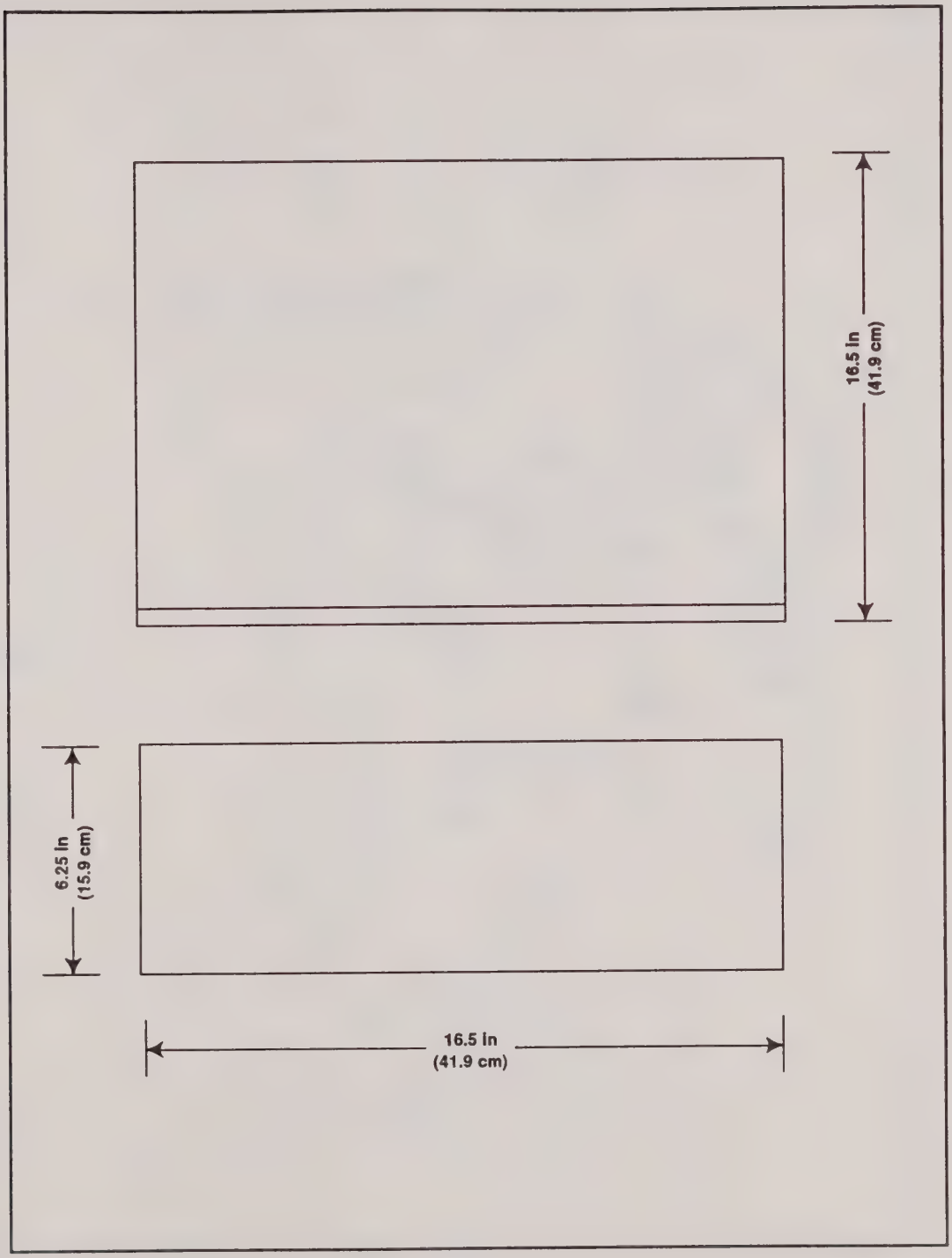


Figure 2-2. Dimensions of the UTI Host Computer

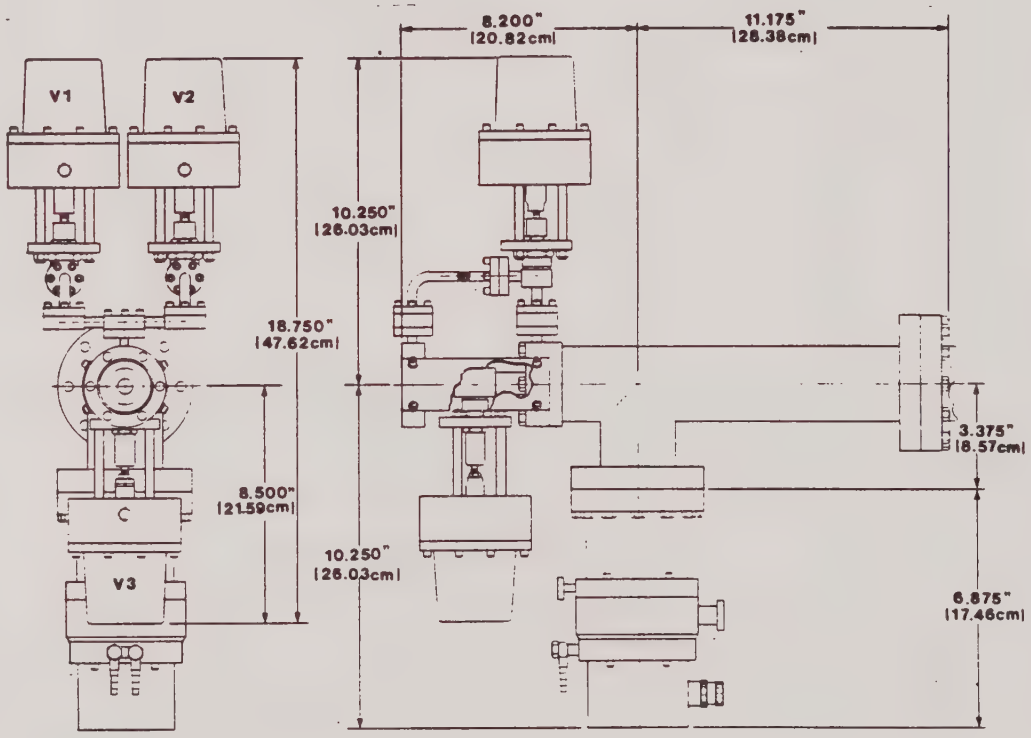


Figure 2-3. Dimensions of the 3PSM Sampling Module

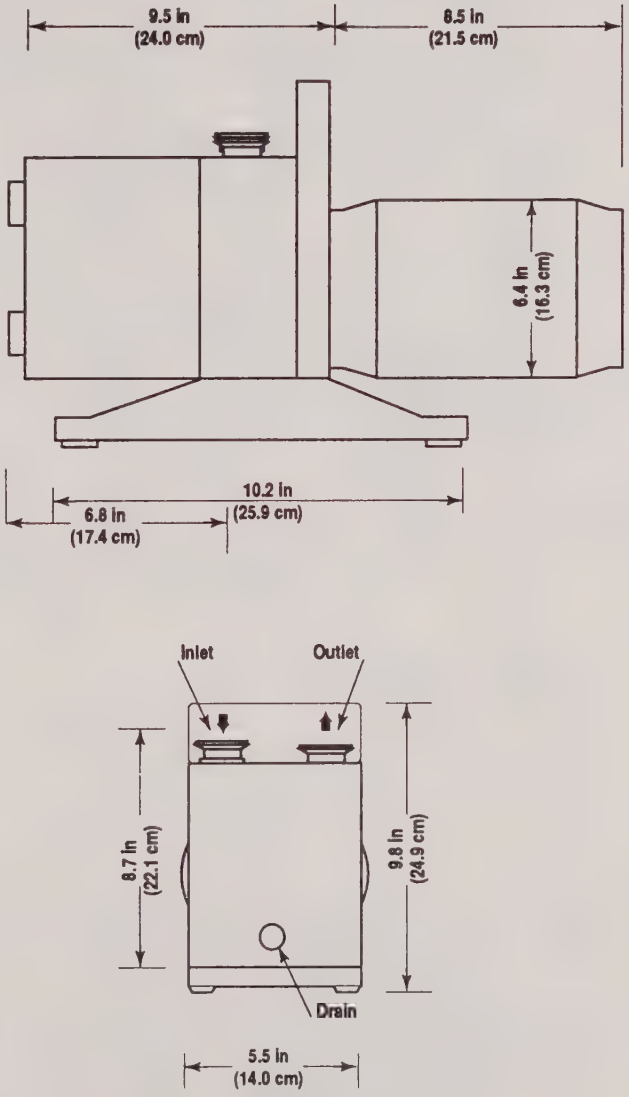


Figure 2-4. Dimensions of the Alcatel Model 2004B Mechanical Pump (3.2 CFM)

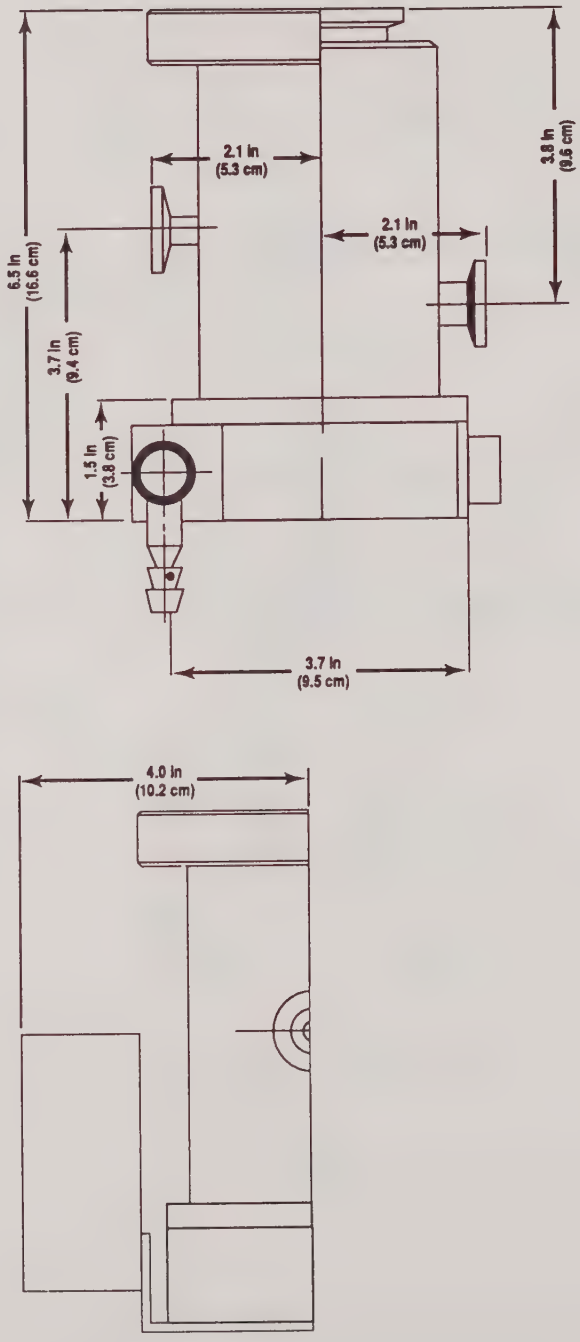


Figure 2-5. Dimensions of the Balzers Model TPU 060 Turbomolecular Pump (60 l/s)

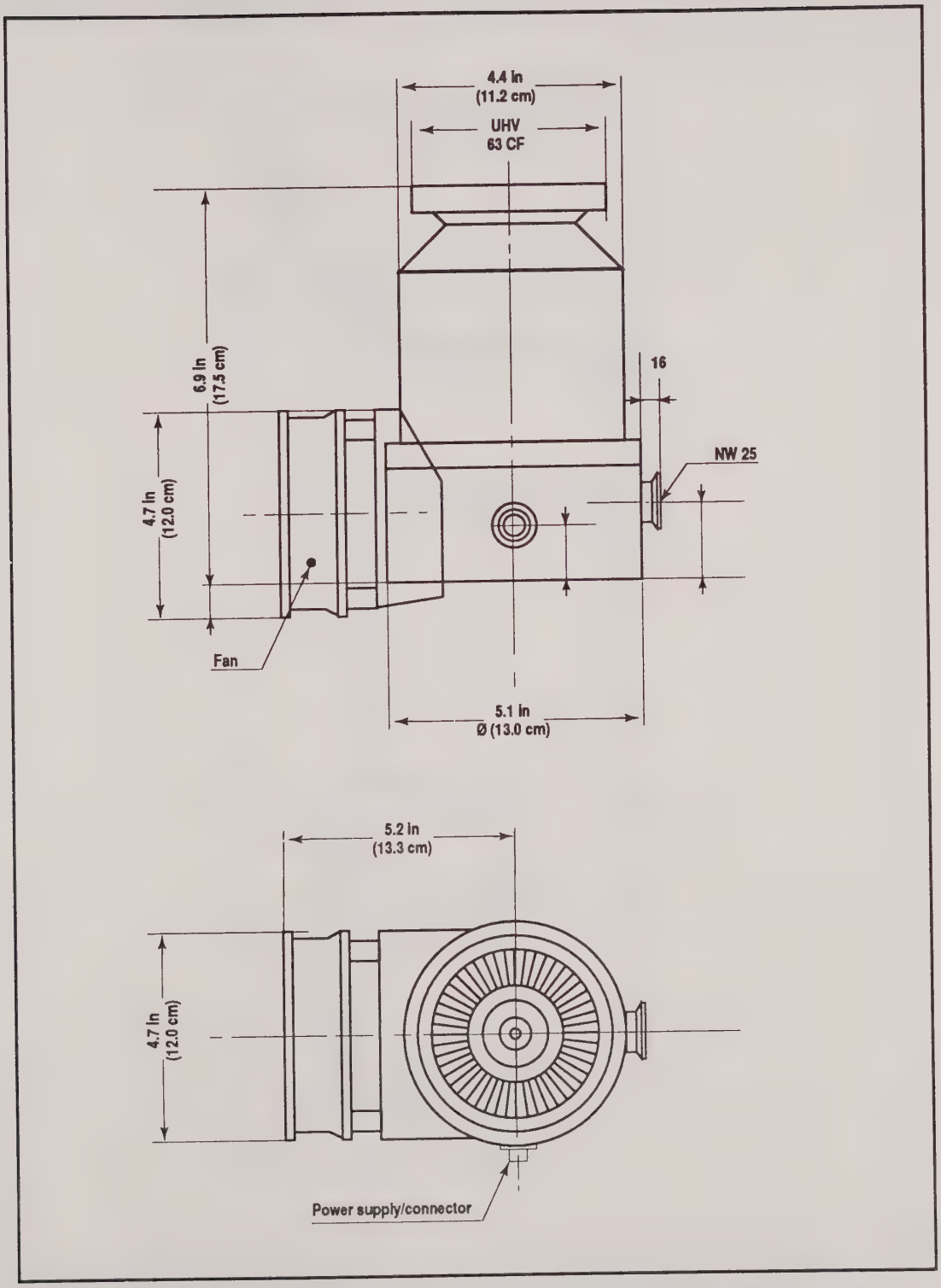


Figure 2-6. Dimensions of the Alcatel Model 5081UHV Turbomolecular Pump (80 l/s)

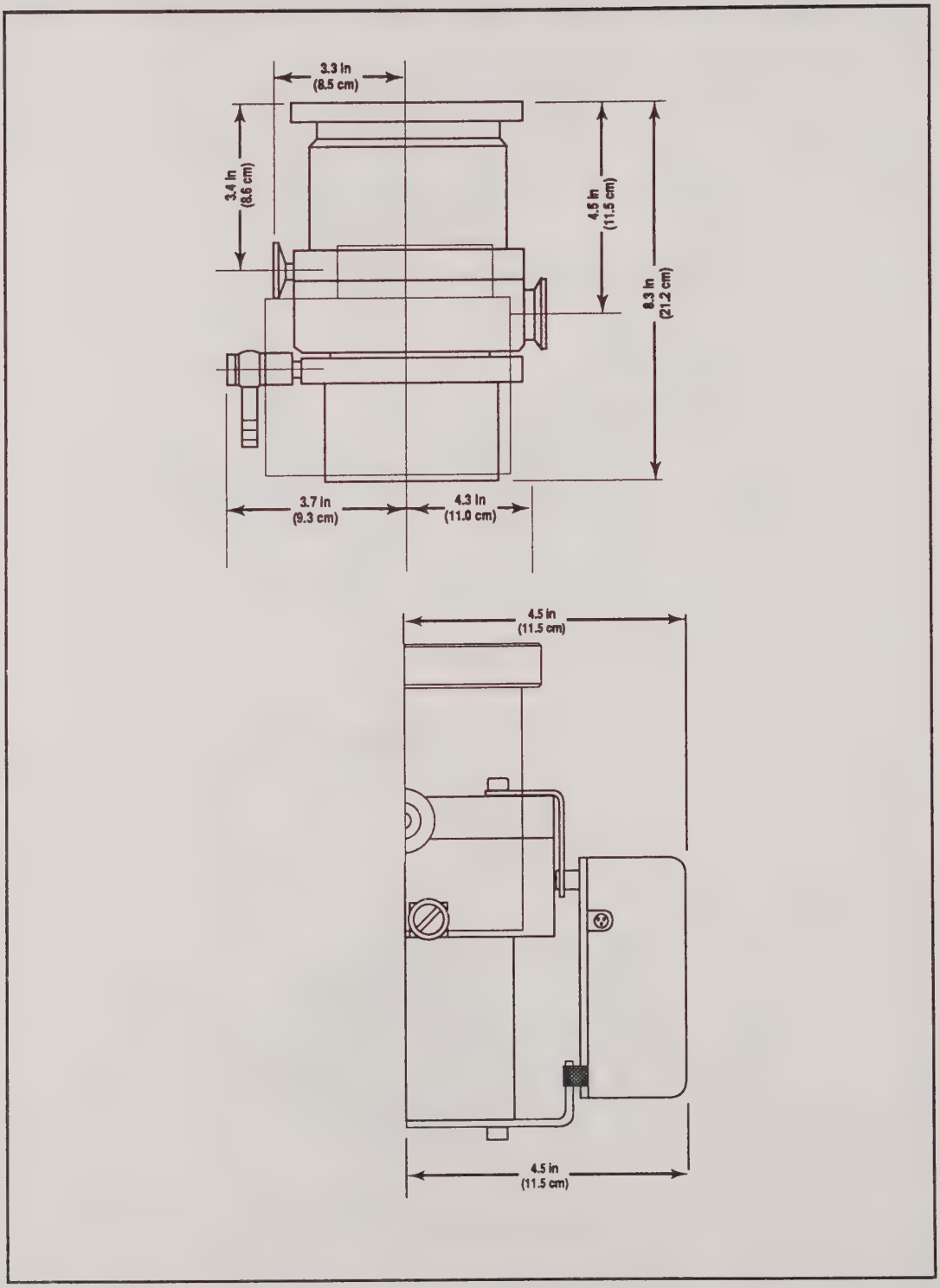


Figure 2-7. Dimensions of the Balzers Model TPU 240 TMP (240 l/s)

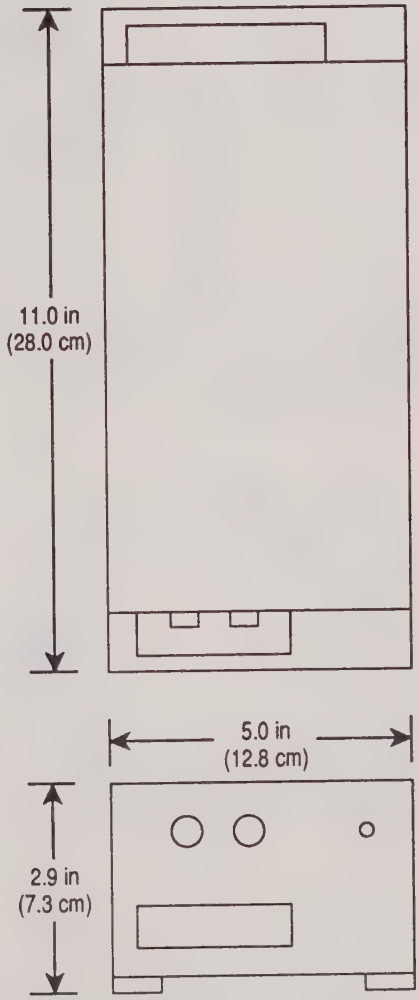


Figure 2-8. Dimensions of the Balzers Model TCP 120 TMP Electronic Controller

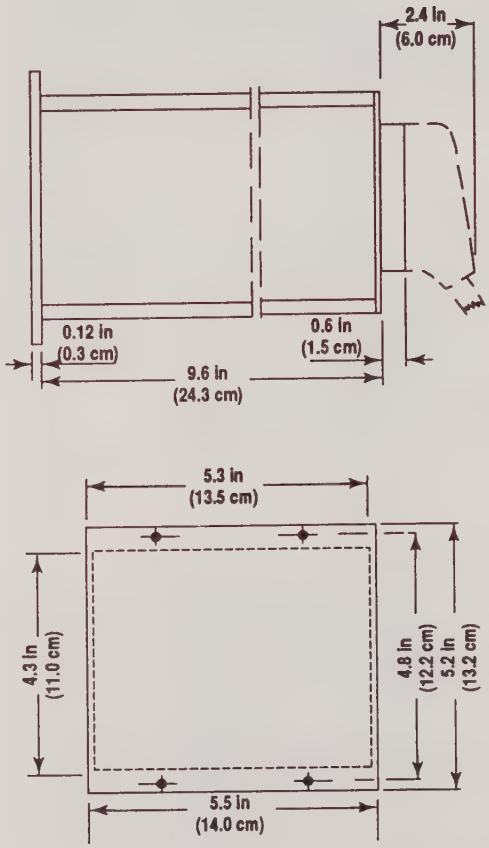


Figure 2-9. Dimensions of the Balzers Model TCP 121 TMP Electronic Controller

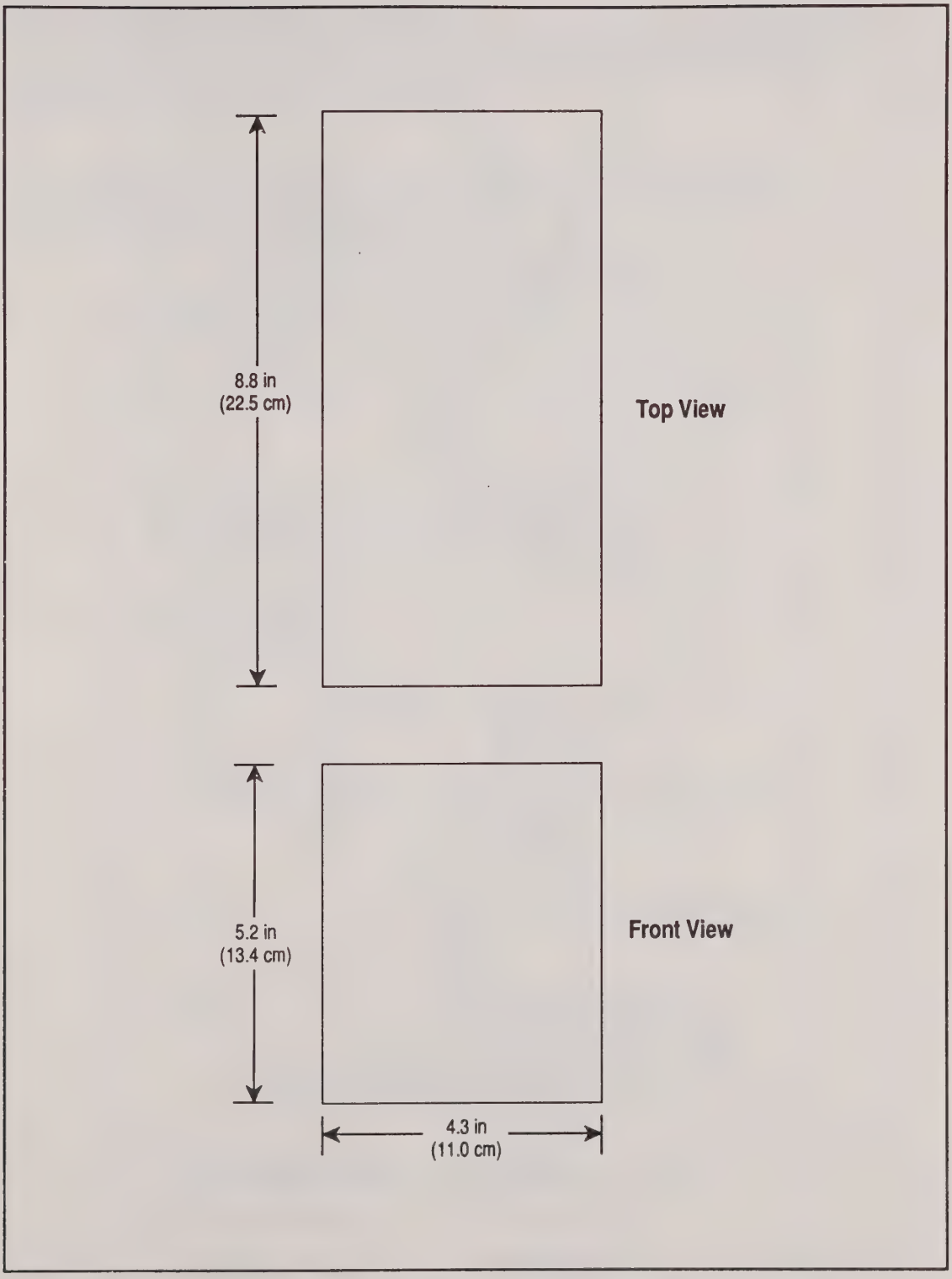
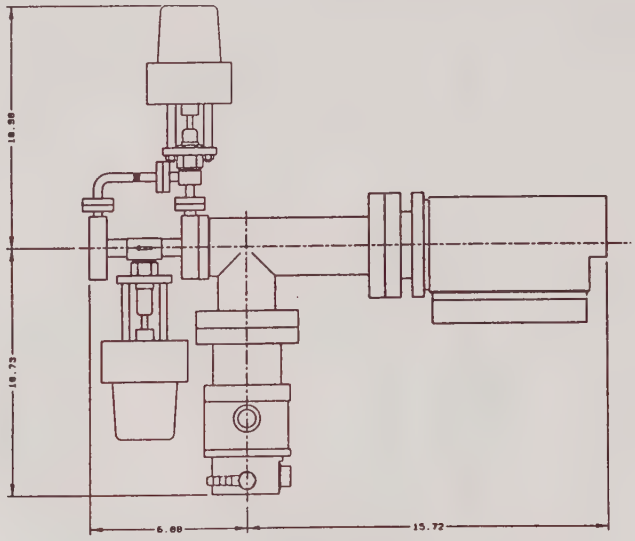
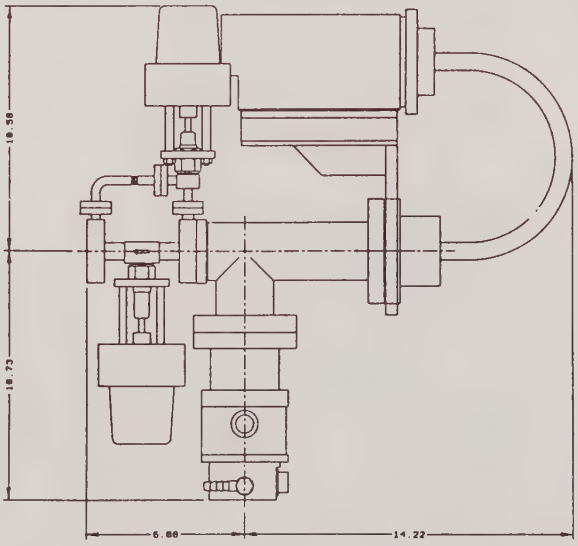


Figure 2-10. Dimensions of the Alcatel Model CFF 100 TMP Electronic Controller



STANDARD ELECTROPNEUMATIC INLET



ELECTROPNEUMATIC INLET WITH
REMOTED RF GENERATOR

Figure 2-11. Dimensions of Short Probe Configurations

2.2 Component Specifications

This section provides tables that summarize the specifications of the QualiTorr Remote System components.

2.2.1 UTI Host Computer

Table 2-3 lists specifications for the UTI Host Computer operated with the Station Controller and the QualiTorr Remote Software.

Table 2-3. UTI Host Computer Specifications

Category	Specifications
Monitor	14-inch VGA Color Graphics
Display	Menu-driven graphics
Pressure Readout	Torr (Absolute), Selectable Number of Decades
Pressures Displayed Simultaneously	Ten
Gas Identification	AMU number, name, or chemical symbol
Tolerance Windows	User defined
Disk Drives	One 3.5-inch (1.44 MB) floppy drive One Hard Disk (40 MB Standard)
Processor	Intel 80386 (Standard), 33 MHz
Data I/O	COM 1 (RS-485), DTE COM 2 (RS-485), DTE COM 3 (RS-232-C), DTE COM4 (RS-232-C), DTE Parallel Printer Port (LPT1) VGA Port
Random Access Memory	4 Mbyte
Host Computer Weight	20 lbs (9.1 kg)
VGA Monitor Weight	25 lbs (11.3 kg)

2.2.2 Station Controller

Table 2-4 lists specifications for the Station Controller.

Table 2-4. Station Controller Specifications

Category	Specifications
Monitor	VGA Color Graphics (Maintenance)
Display	Menu-driven graphics (Maintenance)
Pressures Displayed Simultaneously	Ten (Maintenance)
Gas Identification	AMU number, name, or chemical symbol (Maintenance)
Tolerance Windows	User defined (Maintenance)
Disk Drives	One 3.5-inch (1.44 MB) floppy drive
Processor	Intel 80286 (Standard)
Data I/O	COM 1 (1), COM 1 (2) COM 2 AUX 1, AUX 2 Remote Analog I/O TTL I/O Keyboard (Maintenance) Leakhunter VGA Monitor (Maintenance)
Random Access Memory	1 Mbyte
Station Controller Weight	27 lbs (12.2 kg)

2.2.3 Mechanical Pump

Table 2-5 lists the specifications for the Alcatel Model 2004B (3.2 CFM) mechanical pump.

Table 2-5. Mechanical Pump Specifications (3.2 CFM)

Category	Specifications
Pumping Speed	3.2 CFM (5 m^3h^{-1})
Rotation Speed	1800 RPM
Ultimate Vacuum	<.7 x 10^{-4} Torr
Oil Capacity	8.82 qt (0.75 liter)
Weight	51.8 lb (23.5 kg)

2.2.4 Turbomolecular Pump

Table 2-6 lists specifications for the Balzers Model TPU 060 turbomolecular pump.

Table 2-6. Turbomolecular Pump Model TPU 060 Specifications

Category	Specifications
Pumping Speed	60 l/s
Mechanical Pump Required	3.2 CFM (5 m^3/h)
Ultimate Vacuum (with a two-stage MP and a metal vacuum gasket)	7.5×10^{-10} Torr (1×10^{-7} Pa) (1×10^{-9} mbar)
Rotation Speed	90,000 RPM
Oil Capacity	6.1×10^{-2} cubic in (1 cm^3)
Air Cooling (Standard) Water Cooling (Optional)	--- 4 gal/h (15 l/h)
Weight	5.5 lb (2.5 kg)

Table 2-7 lists specifications for the Alcatel Model 5081UHV turbomolecular pump.

Table 2-7. Turbomolecular Pump Model 5081UHV Specifications

Category	Specifications
Pumping Speed	80 l/s
Mechanical Pump Required	3.2 CFM (5 m^3/h)
Ultimate Vacuum (with a two-stage MP and a metal gasket)	3.75×10^{-9} Torr 5×10^{-7} Pa 5×10^{-9} mbar
Rotation Speed	27,000 RPM
Grease Capacity	0.12 cm^3 in axle orifice 0.05 cm^3 in ball bearings
Cooling	Forced Air Only
Weight	6.6 lb (3 kg)

Table 2-8 lists specifications for the Balzers Model TPU 240 turbomolecular pump.

Table 2-8. Turbomolecular Pump Model TPU 240 Specifications

Category	Specifications
Pumping Speed	240 l/s
Mechanical Pump Required	3.2 CFM (5 m^3/h)
Ultimate Vacuum (with a two-stage MP and a metal vacuum gasket)	7.5×10^{-10} Torr (1×10^{-7} Pa) (1×10^{-9} mbar)
Rotation Speed	43,000 RPM
Oil Capacity	0.36 cubic in (6 cm^3)
Cooling Water (Optional)	4 gal/h (15l/h)
Weight	5.5 lb (2.5 kg)

2.2.5 TMP Power Supply/Controller

Table 2-9 lists the specifications for the Balzers Model TCP 121 power supply/controller used with the Balzers Model TPU 060 and Balzers Model TPU 240 turbomolecular pumps.

Table 2-9. Model TCP 121 TMP Electronic Controller Specifications

Category	Specifications
Rated Frequency	715/1000/1500 Hz
Operating Temperature Range	0-40 °C
Weight	2.2 lb (1 kg)

Table 2-10 lists the specifications for the Balzers Model TCP 120 electronic controller used with the Vacuum System Controller to run the Balzers Model TPU 060 and Balzers Model TPU 240 turbomolecular pumps.

Table 2-10. Model TCP 120 TMP Electronic Controller Specifications

Category	Specifications
Rated Frequency	715/1000/1500 Hz
Operating Temperature Range	0-40°C
Weight	2.2 lb (1 kg)

Table 2-11 lists the specifications for the Alcatel Model CFF 100 electronic controller used to run the Alcatel Model 5081UHV turbomolecular pump.

Table 2-11. Model CFF 100 TMP Electronic Controller Specifications

Category	Specifications
Rated Frequency	450 Hz
Operating Temperature Range	0-50 °C
Weight	4.4 lb (2 kg)

2.3 QualiTorr Remote System Performance Specifications

Table 2-12 lists performance specifications for the QualiTorr Remote System when operated with the QualiTorr Remote Software.

Table 2-12. QualiTorr Remote System Performance Specifications

Category	Specifications
Mass Range	1-200 AMU
Sensitivity	Selectable to 300 amp/Torr
Resolving Power	M/ΔM ≥ 2M through mass range
Repeatability	±0.6% STD per 1 hour for concentration > 10%
Stability	±0.9% STD over 8 hours for concentrations ≥ 10%
Linearity	±1.0% for independent linearity of signal response versus partial pressure input for concentration ranging over 5 decades with constant ion source pressure.
Accuracy (within 120 hours operating time after a calibration which has no more than a 1.5% error)	±1% at 10% concentration ±4% at 0.1% concentration ±16% at 10 ppm concentration ±32% at 1 ppm concentration
Abundance Sensitivity	≥ 5×10^5 with closed source

Table 2-13 lists performance specifications for the QualiTorr Remote System for the various probe and sampling module combinations.

Table 2-13. QualiTorr Remote System Detection Performance Specifications

Category	Pressure Ranges and Sensitivities
Open Ion Source	10^{-5} to 10^{-13} Torr (1.33×10^{-3} to 1.33×10^{-11} Pa) (1.33×10^{-5} to 1.33×10^{-13} mbar)
Closed Ion Source with Sampler	10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa) (13.3 to 1.33×10^{-3} mbar)
Closed Ion Source with APSM	152 to 1520 Torr (2.02×10^{4} to 2.02×10^{5} Pa) (2.02×10^{2} to 2.02×10^{3} mbar)
Closed Ion Source with FRSM	10 to 10^{-3} Torr (5.32×10^{2} to 1.33×10^{-1} Pa) (5.32 to 1.33×10^{-3} mbar)
Sensitivity	Selectable to 300 amp/Torr
Resolution	$M/\Delta M \geq 2M$ through mass range
Minimum Detectable Partial Pressure	1×10^{-13} Torr with the open ion source
Minimum Detectable Quantity	30 ppb (theoretical for a closed source with some gases)

Chapter 3

Unpacking

CAUTION

The shipping containers are heavy. A minimum of two people is required to move the QualiTorr Remote shipping containers to the installation location.

This chapter provides step-by-step instructions on how to properly unpack the QualiTorr Remote's shipping crates, inspect for damage, and inventory the shipment. Before starting to unpack the shipping containers, inspect each crate for visible damage. If any damage is apparent, report it to the carrier immediately.

The total number of boxes you have received depends upon the options that you chose when you purchased the instrument. The standard QualiTorr Remote open and closed ion probe configurations are shipped in large cardboard shipping containers. All components have been wrapped with plastic, covered by a chemical packing foam, and sealed inside the containers. The foam packing requires no cutting for removal of the components. Each component is easily freed from the foam by gently pulling on the component. Some inlet valve configurations require solid foam cut-outs for added protection.

3.1 Removing and Inspecting the Components

To remove the components from the shipping containers, follow these step-by-step instructions for each container:

1. Using standard hand tools, carefully open the outer cardboard shipping container.
2. Carefully remove the packing foam and all of the internal shipping boxes.
3. Carefully open each internal shipping box and remove each component.
4. Remove all shipping bags and protective coverings, except for any metal foil. See the caution box below.

> **CAUTION**
>
> Do not remove the metal foil that covers the ends of the vacuum components at this time. This protective covering will be removed just prior to installation.

5. Inspect all components for signs of damage.

> NOTE
>
> If any of the components appear damaged in any way, immediately notify the shipping agency or carrier and contact your UTI instruments field service representative.

6. Save all of the shipping containers, packing foam, and plastic bubble-wrap. If any components have been damaged, your shipping representative will want to inspect the packing materials. Store the shipping containers and materials in a safe place so that they will be available in the event that shipment back to the factory is ever required.

3.2 Basic System Components

Each standard QualiTorr Remote System has the following components:

- ❒ Station Probe.
- ❒ Station Controller.
- ❒ UTI Host Computer.
- ❒ Power cords.
- ❒ Installation and maintenance manual (this document).
- ❒ Interconnect cables.
- ❒ Station Controller Software: QualiTorr Remote System Disk (Station Probe-Specific) for use in *Host Computer Mode* and QualiTorr Remote Local III Simulator for use in Local *Maintenance Mode*. UTI Host Computer Software is pre-installed on the Hard Disk.

> **SPECIAL NOTE**
>
> UTI Probes, RF Generators and Remote Station Controllers are carefully matched at the factory, and must be installed as a matched set. Serial numbers appear on each unit. See the "Calibrated As A System" tag located on the RF Generator and Remote Station Controller to confirm the "Control," "RF Generator" and "Probe" Serial Numbers (S/N). Probe serial numbers are on the outer circumference of the 4 1/2" flange, and may be covered by an RF Generator clamp.

If you have ordered the QualiTorr Remote open source ion probe configuration, proceed to Section 3.3.

If you have ordered the QualiTorr Remote closed source ion probe configuration, proceed to Section 3.4.

3.3 Open Source Configuration

The QualiTorr Remote open source configuration consists of the basic system components and the following additional components:

- ❒ Open source probe assembly (mounted in a special shipping tube).
- ❒ Conflat flange copper gaskets, 2.5-inch ID.

> NOTE
>
> If any of the components appear damaged in any way, immediately notify the shipping agency or carrier and contact your UTI instruments field service representative.

In addition to the standard components listed, the optional accessories and spare parts that you have ordered have also been included in your shipment.

> NOTE
>
> Check the inventory of the standard and optional components that you have received against your original purchase order. If any of the components are missing, immediately contact your UTI instruments sales representative.

If all of the components have been safely received, the next step is to install your QualiTorr Remote. Proceed to Chapter 4.

3.4 Closed Source Configuration

The QualiTorr Remote closed source configuration consists of the basic system components and the following additional components:

- ❒ Sampling module.
- ❒ Closed source assembly (mounted to the end of the sampling module).
- ❒ Turbomolecular pump (mounted to the bottom of the sampling module).
- ❒ Mechanical pump (shipped in a separate box with oil removed).
- ❒ Turbomolecular pump controller.
- ❒ RF module.
- ❒ Thermocouple gauge meter (wrapped in bubble wrap).
- ❒ Mechanical pump oil (plastic bottle wrapped in bubble wrap).
- ❒ Heating mantles (one for the sampling valves and one for the sampling module).
- ❒ Conflat flange copper gaskets, 2.5-inch ID.
- ❒ Conflat flange copper gaskets, 1.5-inch ID.
- ❒ Assorted cables and fittings (packed in a bag with the gaskets).

> NOTE
>
> If any of the components appear damaged in any way, immediately notify the shipping agency or carrier and contact your UTI instruments field service representative.

In addition to the standard components listed, the optional accessories and spare parts that you have ordered have also been included in your shipment.

> NOTE
>
> Check the inventory of the standard and optional components that you have received against your original purchase order. If any of the components are missing, immediately contact your UTI instruments sales representative.

If all of the components have been safely received, the next step is to install your QualiTorr Remote System. Proceed to Chapter 4.

Chapter 4

Installation

This chapter provides step-by-step installation, checkout, and certification procedures for the QualiTorr Remote System. The beginning the installation procedures described in this chapter. The installer should proceed through the sections of this chapter sequentially, unless otherwise instructed in the text. If you are unfamiliar with working with high vacuum apparatus or just want to know more about the topic, it may be helpful to read Appendix A titled *Vacuum System Considerations* before starting to install the QualiTorr Remote's components.

4.1 Introduction

The QualiTorr Remote System uses a versatile and modular design to meet the process monitoring requirements of process chambers having an extremely wide range of pressures. Section 4.2 provides the installation procedures for the open source probe configuration and Section 4.3 provides the installation procedures for the closed ion source probe configuration.

SPECIAL NOTE

UTI Probes, RF Generators and Remote Station Controllers are carefully matched at the factory, and must be installed as a matched set. Serial numbers appear on each unit. See the "Calibrated As A System" tag located on the RF Generator and Remote Station Controller to confirm the "Control," "RF Generator" and "Probe" Serial Numbers (S/N). Probe serial numbers are on the outer circumference of the 4 1/2" flange, and may be covered by an RF Generator clamp.

Pneumatic valves require a nitrogen pressure at 110 to 120 psi in order to activate. A nitrogen source with pressure of 60 to 80 psi can be increased to the required 110 to 120 psi pressure by the use of the optional UTI Pneumatic Multiplier.

The QualiTorr Remote also provides a leak detector for finding leaks in high or low vacuum systems. An optional hand-held indicator is available. Section 4.5.4 provides installation and checkout procedures for the *Leak Hunter*.

If your QualiTorr Remote came with an open source ion probe, proceed to Section 4.2.

If your QualiTorr Remote came with a closed ion source probe with the associated sampler module, proceed to Section 4.3.

4.2 Open Source Probe Configuration

Installation of the QualiTorr Remote open ion source probe configuration consists of mounting the probe on the process chamber, attaching the RF module to the open source probe, and connecting the RF module's cable.

4.2.1 Probe Installation

The major consideration regarding probe location should be to achieve maximum sensitivity to the volume being monitored. If the user desires to monitor evaporating metals as well as residual and process gases, the ionizer should have an unobstructed line-of-sight to the evaporating source. If considerable exposure to metal vapors is anticipated, appropriate shielding should be considered to minimize metalization of components of the probe or any of the ceramic insulators. The performance of the analyzer is not affected by its orientation on the process chamber. There is no orientation that must be avoided.

Two methods of so called "nude" probe installation using ports into the process chamber are shown in Figure 4-1. The bottom diagram in Figure 4-1 shows the probe fully inserted into the chamber. Alternatively, the top diagram in Figure 4-1 shows the probe mounted a convenient distance from the process. This design requires that the installer make an appropriate adapter with a 4.5-inch ConFlat flange to match the open ion source probe flange on one end and whatever size Conflat flange or other high vacuum flange is necessary for mounting to the process chamber.

If the probe is mounted on a system that is baked before or during operation, the probe housing (if any) should be kept at the same temperature or higher to prevent condensable vapors from collecting in the probe housing and distorting the analysis. The probe is bakeable to 300 °C (maximum) with the external cables disconnected and the RF Generator removed, and will operate at temperatures up to 180 °C.

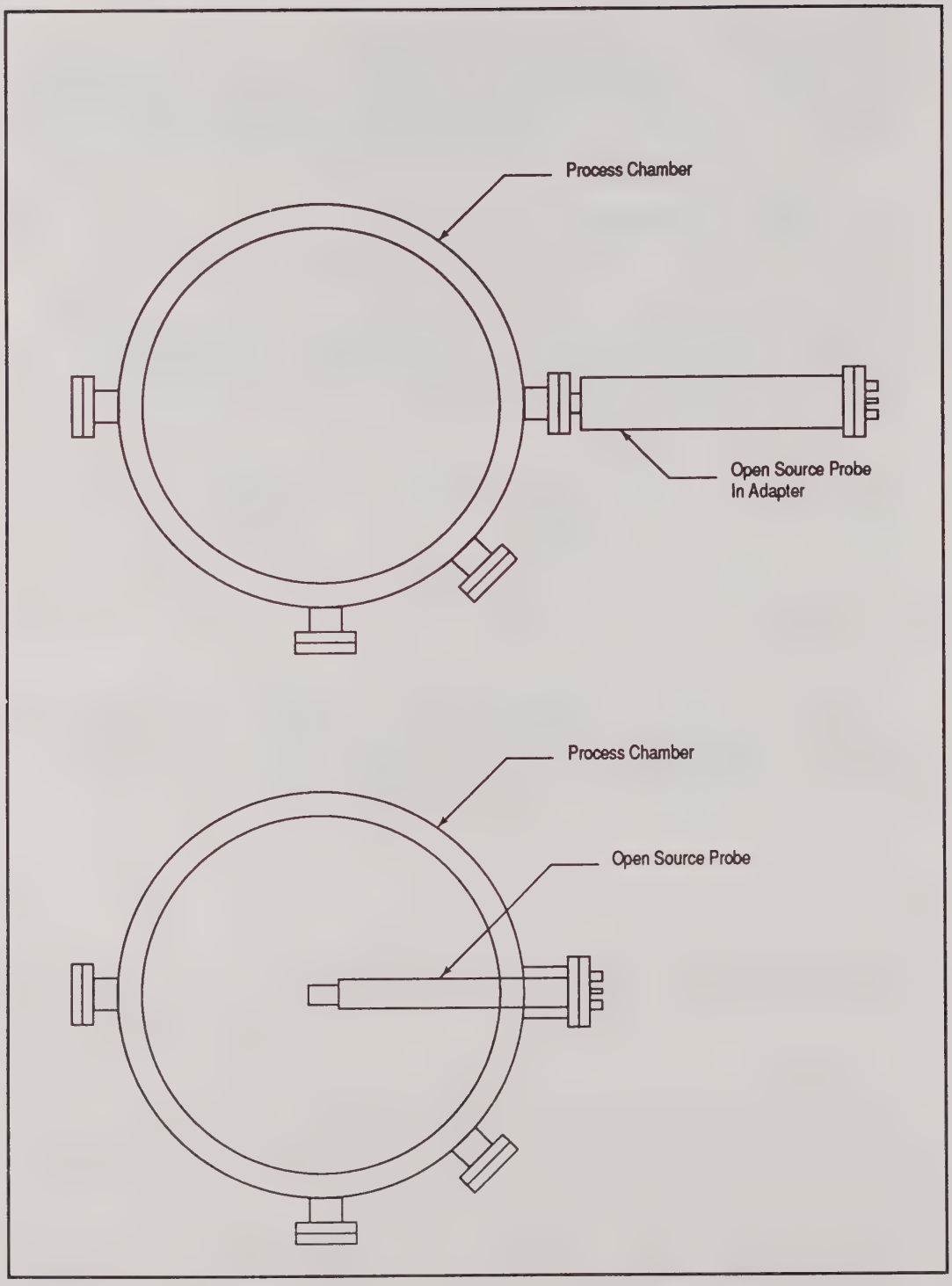


Figure 4-1. Open Ion Source Probe Mounting Configurations: Fully Inserted (Bottom) and Appendaged (Top)

To install the open ion source probe on your process chamber, follow these steps:

> **CAUTION**
>
> **The open ion source probe is extremely vulnerable to damage and contamination during the installation procedure. These steps must be followed with surgeon-like precision in a clean dust-free environment. Under no circumstances is any part of the probe to be touched or to come into contact with any object during this procedure.**

1. Put on a fresh pair of latex or rubber gloves to prevent the transfer of moisture and body oils to the probe. The disposable variety is ideal, but do not use the type that provides powder inside.

2. The open ion source probe is shipped in a specially fabricated housing. See Section 5.3.1 for a detailed explanation of how to carefully remove the open ion source probe from its shipping container. Read the caution box and Step 3 before removing the probe from its shipping container.

> **CAUTION**
>
> **Do not remove the probe from its shipping container before you are ready to immediately mount the probe onto the prepared process chamber. Try to conduct Steps 2 and 3 in one continuous sequence.**

3. See Section 5.3 for a detailed explanation of how to insert the probe into the prepared process chamber's 4.5-inch Conflat flange. Use a new Conflat copper gasket for the fitting. Conflat copper gaskets are NOT reusable.

4. When the probe is in position, insert the eight bolts with washers and attach the nuts. Tighten each nut until it is holding the weight of the probe. Then, sequentially tighten each nut in a circular pattern using two or more cycles until the two Conflat flanges are in contact.

5. If there was any indication of rough handling of the probe during shipping, it is useful to make some simple ohmmeter measurements on the probe to check for continuity and shorts before the RF generator is mounted. See Section 9.11 for an explanation of the probe check procedure.

6. Proceed to Section 4.3.5 for instructions on how to install the RF generator.

4.3 Closed Ion Source Probe Configuration

The QualiTorr Remote System inlet–sampling manifold choices offers users a variety of options regarding the number of inlet valves, number of pressure-reduction orifices and their sizes, and the type of valve operating control – manual or pneumatic.

These configurations reflect various needs and requirements for sampling and monitoring of gases as found within the manufacturing processes of the semiconductor industry, or other research or specialized applications where operational pressures range from 1520 to 10^{-4} Torr (2.02×10^{5} to 1.33×10^{-2} Pa or 2.02×10^{3} to 1.33×10^{-4} mbar). The pressure is reduced by the sampling module so that the pressure at the closed ion source probe ranges from 10^{-3} to 10^{-4} Torr (1.33×10^{-1} to 1.33×10^{-2} Pa or 1.33×10^{-3} to 1.33×10^{-4} mbar). This is accomplished by routing the process gas through a flow restricting path called an orifice. The amount of pressure reduction can be selected to match the process pressure by selecting the proper orifice (hole) diameter. Sampling modules are available to quickly and efficiently accommodate one or more processes that require one, two, three, or four different nominal process pressures. These pressure requirements are accommodated by the 1PSM, 2PSM, 3PSM, 4PSM, APSM, and FRSM pressure-reduction sampling modules. For additional information concerning orifice size selection, see Appendix B.

The 1PSM valve configuration provides either a single orifice for pressure reduction to the closed ion source probe or a high conductance valve. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

The 2PSM valve configuration, shown in Figure 1-5, provides a single orifice for pressure reduction to the closed ion source probe and a high conductance valve to monitor low pressure processes. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

The 3PSM valve configuration, shown in Figure 1-6, provides two valved orifices for pressure reduction to the closed ion source probe. The high conductance valve provides the ability to also monitor a low pressure process. These three selectable pressure regions are independent and their operating conditions may, therefore, differ considerably from each other. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

The 4PSM valve configuration provides three valved orifices for pressure reduction to the closed ion source probe. The high conductance valve provides the ability to monitor a low pressure process. These four selectable pressure regions are independent and their operating conditions may, therefore, differ considerably from each other. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar). This valve configuration is available with either manual or pneumatic valve activation.

The APSM configuration, shown in Figure 1-7, extends the pressure range accessible with the 1PSM, 2PSM, 3PSM, and 4PSM valve configurations.to accommodate pressures greater than 4 Torr. This sampling module provides for linear sampling over one decade of pressure while maintaining compositional integrity. This module is a pressure-reduction sampling system that reduces sample process sample pressures from 152 to 1520 Torr (2.02×10^{4} to 2.02×10^{5} Pa or 2.02×10^{2} to 2.02×10^{3} mbar) to the working range of the closed ion source probe. Two pressure-reduction stages are used to maintain the integrity of the original sample composition.while sampling high process chamber pressures. The APSM can be configured for only one process gas pressure at a time. However, the single pressure-reduction set of two orifices can easily be changed to accommodate other process pressures.

The FRSM configuration provides the closest possible coupling between the gas analyzer and the process chamber. This geometry optimizes the sensitivity and response of the special fast response ion source probe that combines the functions of both the probe and a single orifice pressure reduction stage. This sampling module is designed to allow the QualiTorr Remote to quantitatively monitor process pressures that range from 10 to 10^{-3} Torr (1.33×10^{3} to 1.33×10^{-1} Pa or 13.3 to 1.33×10^{-3} mbar).

The pressure-reduction orifices may be selected from diameters ranging from 1 mil to 500 mils (0.025 to 12.70 mm) range, depending upon the pressure regimes that the system will be monitoring. See Appendix B Orifice Selection for a discussion of the selection of pressure-reduction orifices.

The orifices that you selected with your UTI sales representative have already been installed and tested at the factory. The orifice hole diameters that have been installed have been written on a tag and attached to their respective valves. Before proceeding, turn to Appendix B and confirm that the orifices that have been installed are suitable for the process gas pressures and corrosiveness that the QualiTorr Remote will be exposed to. If the orifice diameters are not correct or if the process requires that the orifice be gold plated, select the orifice having the proper size and material type from Table B-1 and turn to Section 5.2 for instructions on how to remove the present orifice and how to replace it with the correct size. If you don't have the correct orifice, turn to Table 10-7 to obtain the correct order number. Then, contact your UTI sales representative.

4.3.1 System Sampling Module Installation

Reference: Figure 4-2

The sampling module is shipped with the closed ion source probe, turbomolecular pump, and sampling system already assembled and tested just prior to shipment.

To install the system sampling module assembly, follow these steps:

1. Remove the aluminum foil covering the ends of the sampling module.

2. Ensure that the process chamber to be monitored has a 2.75-inch Conflat flange available with sufficient room around it to host the sampling module, probe, and RF module. This assembly projects a distance of approximately 26 inches (66 cm) from the process chamber flange. If a Conflat flange is not available on the process chamber, an adapter must be fabricated to accommodate the mating of the Conflat flange on the sampling module with the flange on the process chamber, as shown in Figure 4-2.

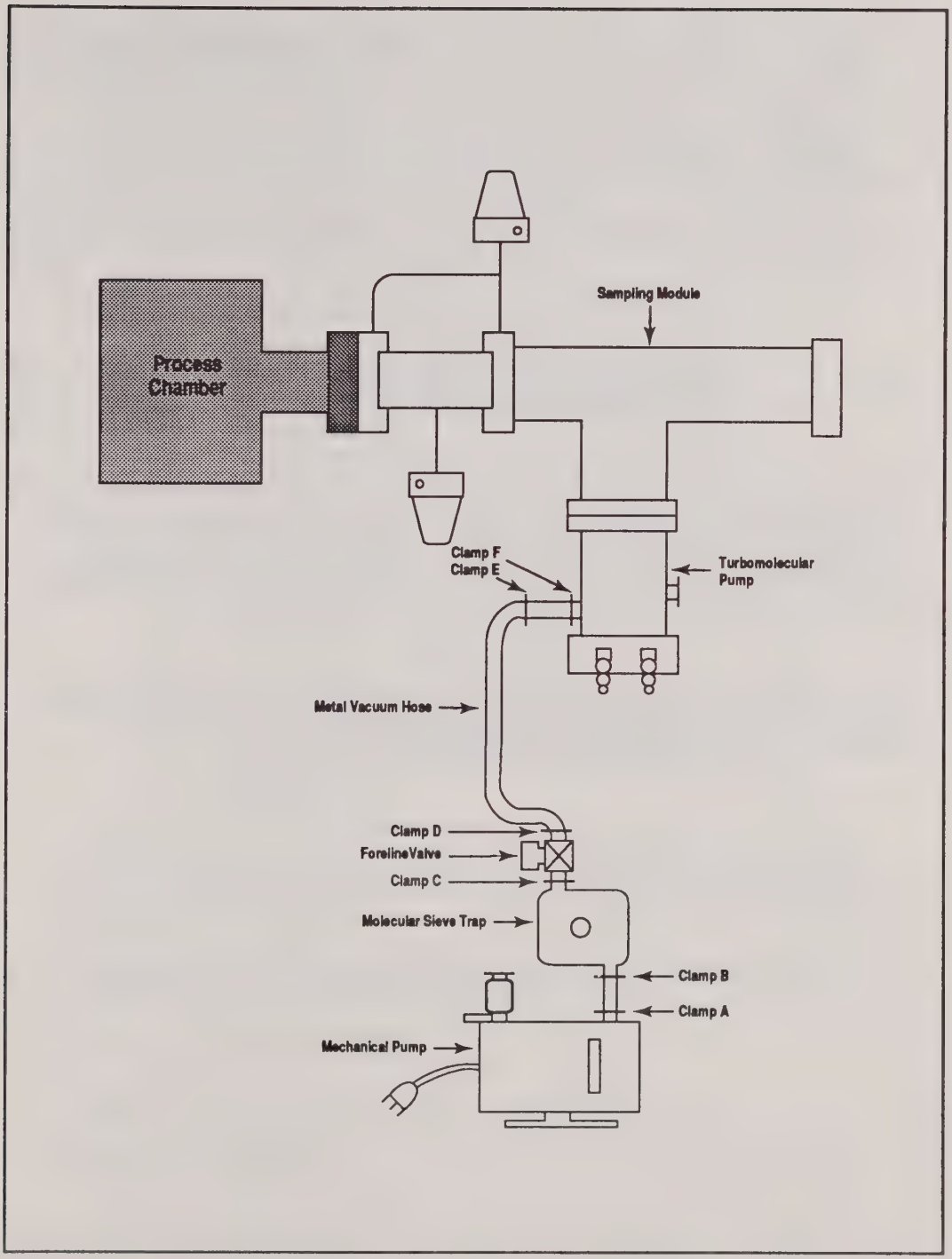


Figure 4-2. QualiTorr Remote Vacuum Connections

3. Connect the QualiTorr Remote system's 2.75–inch Conflat flange to its respective flange on the vacuum process system that it is to monitor. The system can be mounted in any configuration that positions the axis of the Model TPU 060 or TPU 240 TMP between 0° (TMP under the sampler) and 90° (TMP to the side of the sampler). The standard configuration is with the TMP mounted under the sampler (vertically), as shown in Figure 4-2. The Model 5081UHV may be positioned on any axis, including upside-down.

CAUTION

The sampling system must not be mounted so that the Model TPU 060 or TPU 240 turbomolecular pump is operated in an upside down position. If the one of these TMPs is mounted horizontally, its exhaust must be pointed toward the floor.

Connecting the mounting flange to the process–vacuum system flange requires a clean, copper gasket between these flanges, the correct mating of the two flanges, and securing this union by fastening its six bolts. Ensure that the connection of the sampling manifold to the process system is completed without any contamination of the flange or the interior probe chamber (i.e., no fingerprints, hair, contaminants, etc.). See Section 5.1 for the recommended procedure for installing Conflat flanges.

Pneumatic valves require a nitrogen pressure at 110 to 120 psi in order to activate. A nitrogen source with pressure of 60 to 80 psi can be increased to the required 110 to 120 psi pressure by the use of the optional UTI Pneumatic Multiplier.When the sampling module has been mounted, proceed to Section 4.3.2.

4.3.2 Turbomolecular Pump

Reference: Figure 4-2

The turbomolecular pump that you ordered has already been installed on the sampling module that was mounted to the process chamber in Section 4.3.1. The pump has been shipped with oil, and, except for power and cooling connections, is ready to go. You have either a Balzers TPU 060 with a pumping speed of 60 liters per second (l/s), the Alcatel Model 5081UHV with a pumping speed of 80 l/s, or the Balzers Model TPU 240 with a pumping speed of 240 l/s. Air-cooling is standard on your TMP. If your TMP is water-cooled, proceed to Section 4.3.2.1; if your TMP is air-cooled, proceed to Section 4.3.2.2.

4.3.2.1 Water-cooled TMP

The Balzers Model TPU 060 needs to be cooled only during bakeout. The Balzers Model TPU 240 needs to be cooled at all times.

To prepare the water-cooled TMP for operation, follow these steps:

1. Ensure that a continuous source of cool clean water is available. The TMP requires that the water be supplied at a flow rate of 15 liters per hour and have a temperature of approximately 15 °C.

> **CAUTION**
>
> **The water-cooled TMP must have a continuous source of water during operation to remove frictional heat produced during normal operation and during system bakeout.**

2. Connect one of the supplied water hoses to the water supply and connect the other end to one of the hose nipples on the TMP. Either hose nipple may be used for the entrance and exit of the water.

3. Connect another hose to the other TMP hose nipple and ensure that the other end leads to a drain that is not prone to clogging.

4. Attach the power cable to the TMP.

5. Attach the bakeout heater to the TMP.

6. Proceed to Section 4.3.3.

4.3.2.2 Air-cooled TMP (Standard)

The Balzers Model TPU 060 needs to be cooled only during bakeout. The Alcatel Model 5081UHV and Balzers Model TPU 240 need to be cooled at all times.

To prepare the air-cooled TMP for operation, follow these steps:

1. Ensure that the area around the fan and TMP provides sufficient room for good air circulation.

> **CAUTION**
>
> **The air-cooled TMP must provide a continuous source of air during operation to remove frictional heat produced during normal operation and during bakeout.**

2. Attach the power cable to the TMP.
3. Attach the bakeout heater cable to the TMP.
4. Proceed to Section 4.3.3.

4.3.3 Mechanical Pump

Reference: Figure 4-2

To prepare your mechanical pump for operation, follow these steps:

1. Check your pump for a tag that will tell you whether or not your pump has been shipped with oil. The tag looks like this:

> **NOTICE**
> **PUMP IS SHIPPED WITHOUT OIL INSTALLED**
>
> **CAUTION**
>
> Remove shipping plugs from the intake and exhaust port before filling pump with oil.
> Change pump with vacuum pump oil supplied with pump and maintain oil level in middle of sight glass.
>
> **DO NOT OVERFILL**
>
> Oil maintenance is required for proper operation and performance; the longevity will depend upon system application and cleanliness.

   If you don't find this tag, proceed to Step 2. If you do find this tag, proceed to Step 3.

2. You have probably ordered your mechanical pump with Fomblin oil, a silicon oil that is especially resistant to oxidation. If this is the case, double check the oil level window on one end of the pump and confirm that the pump is filled with oil. This may necessitate you agitating the pump to determine where the air/oil interface is. If the oil is not filled to the middle of the sight glass, remove the vacuum clamps and seals from the intake and exhaust port and fill the pump with Fomblin oil until the oil level is correctly in the middle of the window. **Do Not Mix Fomblin Oil With Hydrocarbon Oil.** Replace the shipping vacuum clamps and seals until you are ready to proceed with the installation of the mechanical pump hardware. See Section 7.2.1 for additional information regarding adding oil. Once the pump is filled with oil, proceed to Section 4.3.4.

3. Your pump has been shipped without pump oil. When the mechanical pump is ordered with organic pump oil, the pump oil is drained at the factory and must be replaced before operation. You will need to fill the pump to the proper operating level before operating the pump. A plastic container with the required oil has been shipped with the pump. Remove the shipping plugs from the intake and exhaust port and fill the pump until the oil level is correctly in the middle of the window. See Section 7.2.1 for additional information regarding adding oil. Once the pump is filled with oil, proceed to Step 4.

4. Use Vacuum Clamp A to install the port extender (if provided) to the inlet port (the port that is closest to the oil window) on the top of the pump.

5. Use Vacuum Clamp B to attach the molecular sieve trap to the port extender. The sieve trap must be filled sufficiently with molecular sieve so that the heater tube is covered. Add additional molecular sieve from that supplied with the pump, as required, before proceeding to the next step.

6. Use Clamp C to attach the ball valve and thermocouple detector to the top of the molecular sieve trap. The thermocouple detector is used for monitoring the pressure at the mechanical pump, sometimes called the roughing or foreline pump.

7. Use Clamp D to attach the metal vacuum hose to the pneumatic valve on the mechanical pump. Pneumatic valves require a nitrogen pressure at 110 to 120 psi in order to activate. A nitrogen source with pressure of 60 to 80 psi can be increased to the required 110 to 120 psi pressure by the use of the optional UTI Pneumatic Multiplier.

8. If the installation site has an exhaust manifold for connection of gas exhaust, you will connect the mechanical pump exhaust to the site exhaust system and you will not need to install the mist eliminator on the mechanical pump. If the installation site requires that the exhaust be vented into the room, install the mist eliminator on the exit port of the mechanical pump. The mist eliminator is a directional type, and it must be correctly mounted. Correct mounting is determined by locating the end of the mist eliminator where a white cartridge is internally visible (or a lighter colored exterior). This is the end that must be connected to the pump's exhaust port.

9. Use Clamp E to attach the metal vacuum hose to the short length vacuum tubing diameter adapter (if provided) and use Clamp F to attach the adapter to the turbomolecular pump.

10. If your QualiTorr Remote System does not include the Atmospheric Pressure Sampling Module (APSM), proceed to Step 11. If your System includes the APSM, a second Mechanical Pump **must** be connected to the Differential Section of the Sampling Module. Repeat Steps 1 through 8 above for the second Mechanical Pump while referring to Figure 4-3. Then, connect the Metal Vacuum Hose from Mechanical Pump-2 to the Differential Section of the APSM. Proceed to Step 11.

11. The QualiTorr Remote vacuum system and sampler module have now been installed. Proceed to Section 4.3.4.

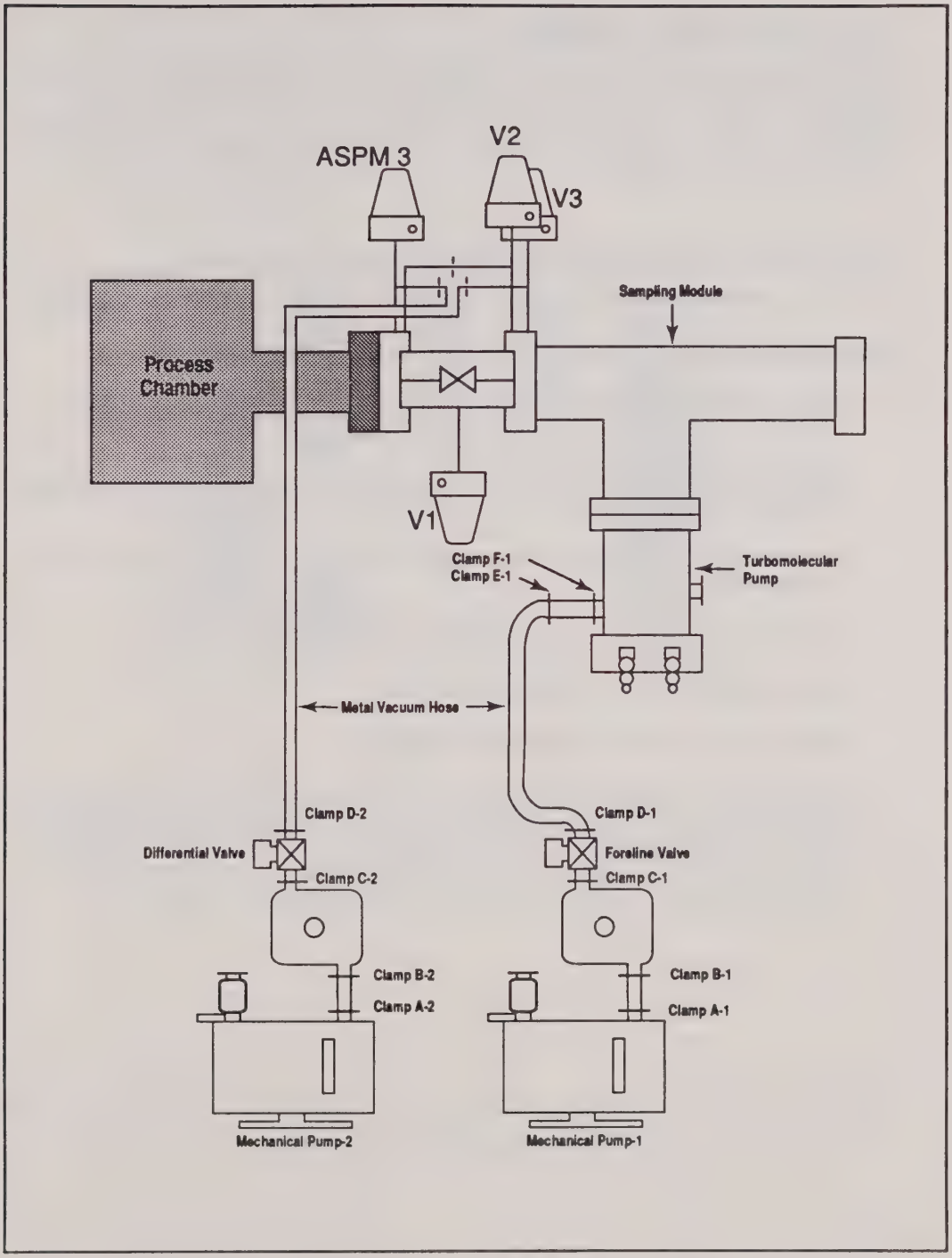


Figure 4-3. APSM Vacuum Connections

4.3.4 Electronic Controller

Your QualiTorr Remote has either been supplied with the Balzers TCP 121 Electronic Drive Unit or the UTI Vacuum System Controller (VSC) or Cart System Controller (CSC) which utilize the Balzers TCP 120 Electronic Drive Unit. If you have ordered the TCP 121, proceed to Section 4.3.4.1. If you have ordered the VSC/TCP 120 or CSC/TCP 120, proceed to Section 4.3.4.2.

4.3.4.1 Balzers Model TCP 121 TMP Electronic Controller

Reference: Operating Instructions Electronic Drive Unit TCP 120/121 and Figure 4-4

To install the TCP 121 Electronic Drive Unit, follow these steps:

1. Ensure that the TCP 121 is located in an environment that provides good air circulation around the unit for cooling purposes.

2. Connect the TMP power cable to the connector marked X5. The connector must be interlocked after plugging in.

3. If the TMP uses air cooling, connect the blower power cord from the TMP fan to connector X2.

4. Connect the vent valve cable on the TMP to connector X1.

5. Connect the TMP heater cable to connector X3.

6. Connect the TCP 121 power cord to connector X4.

7. The TCP 121 is usually switched On when the mechanical pump is started. The TMP start time is delayed by the TCP 121 to allow the system pressure to be reduced before the TMP is activated. This run-up delay time can be set for delays of less than a minute to 30 minutes. The factory delay setting is approximately 8 minutes. Adjust P1 to set the desired delay time. Reference: Figure 4-6.

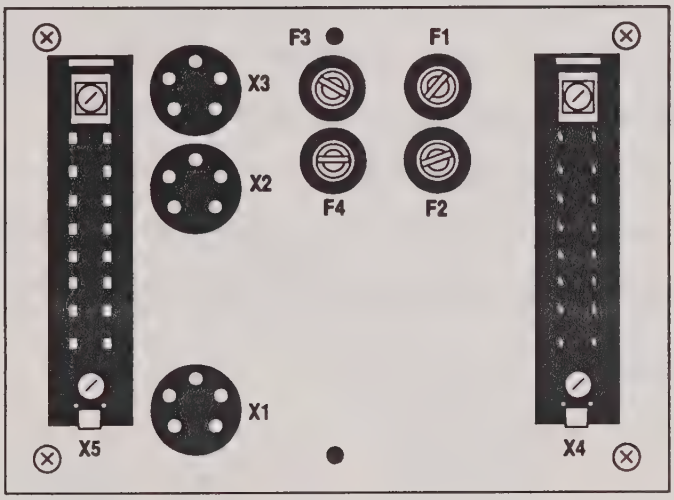


Figure 4-4. TCP 121 Rear Connections

4.3.4.2 Alcatel Model CFF 100 TMP Electronic Controller

References: Instruction Manual: Turbomolecular Pumps and Turbopak With CFF 100 and Figure 4-5

To install the CFF 100 Electronic Drive Unit, follow these steps:

1. Ensure that the TCP is located in an environment that provides good air circulation around the unit for cooling purposes.
2. Connect the TMP power cable to the connector marked J2.
3. Connect the fan power cord from the TMP fan to connector J3.
4. Connect the vent valve cable on the TMP to connector J4.
5. Select the proper voltage (115, 220, or 240 VAC) using the Power Selection Switch.
6. Connect the CFF 100 power cord to J1 and to the power source.

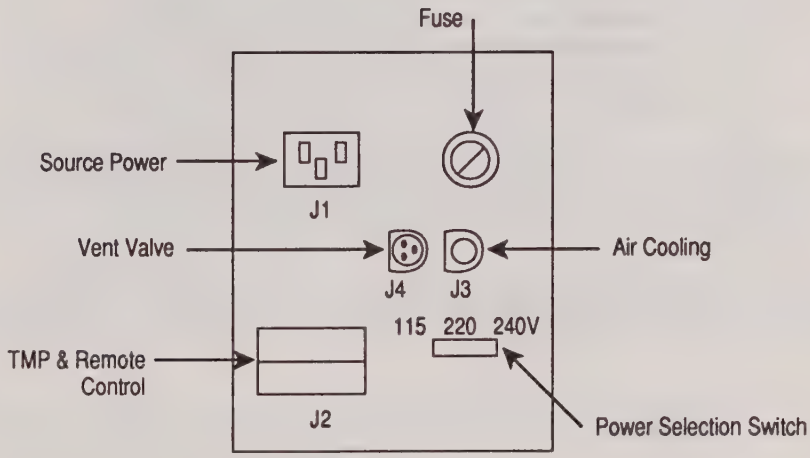


Figure 4-5. CFF 100 Rear Connections

4.3.5 RF Generator

To install the RF generator on the open or closed ion source probe, follow these steps:

1. The RF generator housing attaches directly to the exposed leads of the probe by the use of the screw connector on the RF generator. The screw connector should be firm, but not overly tight.

> **CAUTION**
>
> **The exposed ceramic probe feed-thrus are easily broken when bumped or excessively torqued. Be particularly careful when installing the RF generator that the generator contacts the probe leads on-axis.**

2. The interconnect cable that connects the RF generator to the Station Controller may be up to 100-feet long. Connect the interconnect cable that you have ordered (10, 25, 50, 75, or 100-foot) to the back of the RF generator.

3. When the RF generator and interconnect cable are attached to the open or closed ion source probe, proceed to Section 4.3.6.

4.3.6 System Bakeout

A system bakeout should be conducted following initial installation of the QualiTorr Remote hardware and vacuum electronics, any time that the system is exposed to the atmosphere, or anytime that the contamination level of the system is deemed excessive, as determined by analysis of process spectra. System bakeout consists of raising the temperature of the vacuum components of the system to approximately 150°C for a minimum of 8 hours. System bakeout is accomplished by the heating of the QualiTorr Remote system's sampling manifold and inlet, the system's TMP, and the molecular sieve trap on the system's mechanical vacuum pump. Bakeout is nearly always initiated with the sieve trap.

> **CAUTION**
>
> **The mechanical and turbomolecular pumps must be running during any system bakeout while an inert purge gas such as dry nitrogen is circulating throughout the system to carry away all of the contaminants released from the metal surfaces of the vacuum system during bakeout.**

If you are using the TCP 121 Electronic Controller, proceed to Section 4.3.6.1. If you are using the CFF 100 Electronic Controller, proceed to Section 4.3.6.2.

4.3.6.1 System Bakeout using the Electronic Controller TCP 121

References: Figures 4-6 and 4-7 and Table 4-1

To bakeout only the sampling system (eliminating the molecular sieve trap bakeout), follow Steps 10 through 14.

To conduct a complete system bakeout, follow these steps:

1. Install the heating mantles over the sample module inlet valves and probe section, as shown in Figure 4-6.

2. Plug the TCP 121 into a suitable 115 VAC power source.

3. Ensure that the TCP 121 is Off.

4. Ensure that sampling valves are all closed.

5. Turn the foreline valve above the molecular sieve trap Off to isolate the trap and the mechanical pump from the rest of the vacuum system.

6. Plug in the mechanical vacuum pump and turn it On. The thermocouple vacuum gauge provides a convenient means of monitoring the system pressure. After a few minutes the pressure in the section of the vacuum system that has been isolated should be at the low pressure end of the pressure gauge's range.

7. Plug the molecular sieve trap heater cartridge into a suitable 115 VAC power source, open the mechanical pump ballast, and let the system bake for typically about two hours. It is strongly recommended that a clean gas be purged through the trap while baking. Usually this is done through a VCR orifice in the turbo "leak-up" valve.

8. Unplug or turn off the molecular sieve trap heater from its AC power source and allow the sieve trap to cool for a minimum of one hour at ambient room temperature before baking out the rest of the vacuum system. **Do Not Turn Off The Mechanical Pump.**

9. Once the molecular sieve has been baked out and the sampling module has been partially degassed, you may conduct the system bakeout. Turn Off the mechanical pump ballast.

10. Press S1 on the TCP 121 to start the TMP. **Open Ball or Pneumatic Valve Above Molecular Sieve Trap.**

11. Adjust a flow of "purge gas" into the process chamber through an appropriate inlet valve in order to obtain a total pressure similar to that used in your process. Open the appropriate inlet valve.

12. Plug the two heating mantles into a suitable 115 VAC power source.

13. Press S2 on the TCP 121 to turn on the heater in the TMP.

14. The system should bakeout for 4 to 8 hours.

15. The intent of the bakeout process is to remove background-causing contamination such as water and organics from the vacuum system. Since substances have higher vapor pressures at increased temperatures, the contaminants are effectively boiled from the system. The pumps remove vapors from the system.

> **CAUTION**
>
> **The pumps should remain On and running. If the system is shut down or brought up to atmospheric pressure, then the entire bakeout operation must be performed in its entirety again.**

16. When the bakeout is completed, proceed to Section 4.4.

Table 4-1. TCP 121 Front Panel Controls and Indicators

Control/Indicator	Function
Left Switch, S9	Standby On/Off
Middle Switch, S2	TMP Heater On/Off
Right Switch, S1	Power On/Off
Light Above Left Switch	Standby Indicator
Light Above Middle Switch	TMP Heater Indicator
Luminous Display	Power (Left Indicator) Speed (Right Four Indicators)
Potentiometer, P1	Run-up Time Adjustment

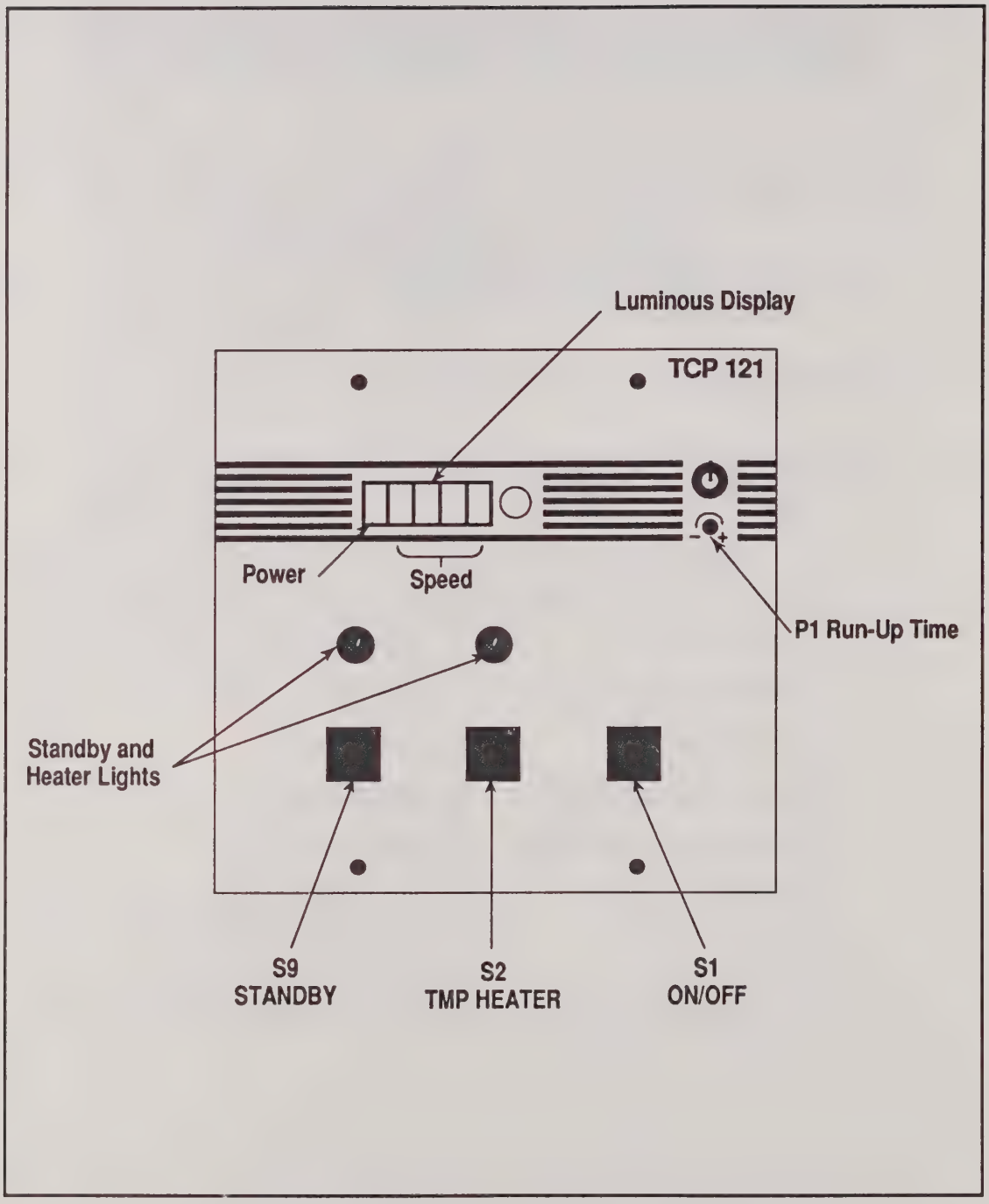


Figure 4-6. TCP 121 Electronic Controller - Front Panel

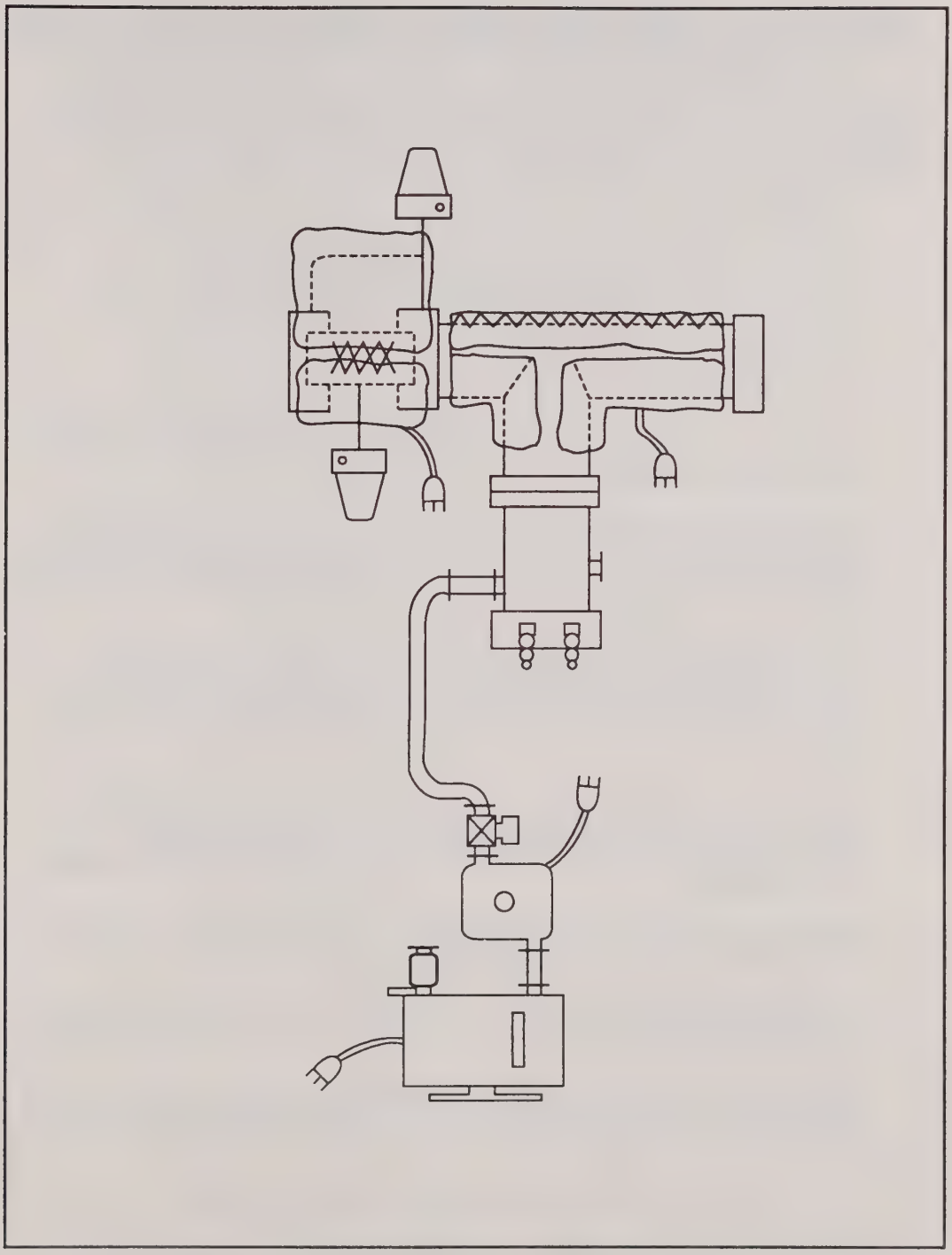


Figure 4-7. Heating Mantle Placement on the Sampling Module

4.3.6.2 System Bakeout using the Electronic Controller CFF 100

Reference: Figure 4-8 and Table 4-2

To bakeout only the sampling system (eliminating the molecular sieve trap bakeout), follow only Steps 10 through 14. To conduct a complete system bakeout, follow these steps:

1. Install the heating mantles over the sample module inlet valves and probe section, as shown in Figure 4-6.

2. Plug the CFF 100 into a suitable 115 VAC power source.

3. Ensure that the TCP CFF 100 is Off.

4. Ensure that sampling valves are all closed.

5. Turn the ball valve above the molecular sieve trap Off to isolate the trap and the mechanical pump from the rest of the vacuum system.

6. Plug in the mechanical vacuum pump and turn it On. The thermocouple vacuum gauge provides a convenient means of monitoring the system pressure. After a few minutes the pressure in the section of the vacuum system that has been isolated should be at the low pressure end of the pressure gauge's range.

7. Plug the molecular sieve trap heater cartridge into a suitable 115 VAC power source, open the mechanical pump ballast, and let the system bake for about two hours. It is strongly recommended that a clean gas be purged through the trap while baking. Usually this is done through a VCR orifice in the turbo "leak-up" valve.

8. Unplug or turn off the molecular sieve trap heater from its AC power source and allow the sieve trap to cool for a minimum of one hour at ambient room temperature before baking out the rest of the vacuum system. **Do not turn Off the Mechanical Pump.**

9. Once the molecular sieve has been baked out, you should conduct the sampling system bakeout after turning off the mechanical pump ballast.

10. Press S1 on the CFF 100 to start the TMP. **Open the ball or pneumatic valve above the molecular sieve trap.**

11. Adjust a flow of "purge gas" into the process chamber through an appropriate inlet valve in order to obtain a total pressure similar to that used in your process. Open the appropriate inlet valve.

12. Plug the two heating mantles into a suitable 115 VAC power source.

13. Press S2 on the CFF 100 to turn on the heater in the TMP.

14. The system should bakeout for 4 to 8 hours.

15. The intent of the bakeout process is to remove background-causing contamination such as water and organics from the vacuum system. Since substances have higher vapor pressures at increased temperatures, the contaminants are effectively boiled from the system. The pumps remove vapors from the system.

> **CAUTION**
>
> **The pumps should remain On and running. If the system is shut down or brought up to atmospheric pressure, then the entire bakeout operation must be performed in its entirety again.**

16. When the bakeout is completed, proceed to Section 4.4.

Table 4-2. CFF 100 Front Panel Controls and Indicators

Control/Indicator	Function
"Start Switch"	Turns On the power to the TMP
"Stop Switch"	Turns Off the power to the TMP
Green Pilot Light	"On" indicates that the converter is producing 450 Hz, as required for the TMP to achieve 27, 000 RPM.
Yellow Pilot Light	"On" may indicate that the TMP is -in a starting period during which the TMP is turning at a speed less than 27,000 RPM. *OR* -in an operating mode in which the speed has been decreased to less than 27,000 RPM as a result of the pumping load from excessive gas in the vacuum system.
Red Pilot Light	"Off" indicates normal operation. "On" indicates that -there is a malfunction. *OR* -the startup period or the overload period has exceeded 7 minutes. *OR* -the motor is not energized and the pump is not running.
Elapsed Time Counter	Records TMP operating time from 0 to 100,000 hours.

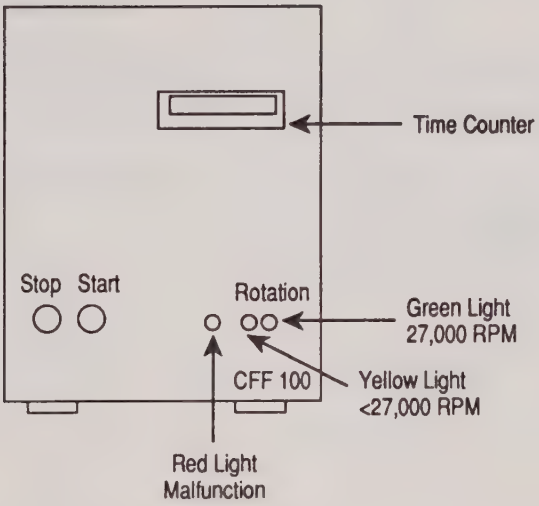


Figure 4-8. CFF 100 Electronic Controller - Front Panel

4.4 Station Controller

Reference: Figure 4-9

If the Station Controller is to be installed in a single probe configuration with a UTI Host Computer, proceed to Section 4.4.1. If Station Controllers are to be installed in a multiple probe multiplexed configuration with a UTI Host Computer, proceed to Section 4.4.2. If the Station Controllers are to be operated by an OEM Host Computer proceed to Section 4.4.3.

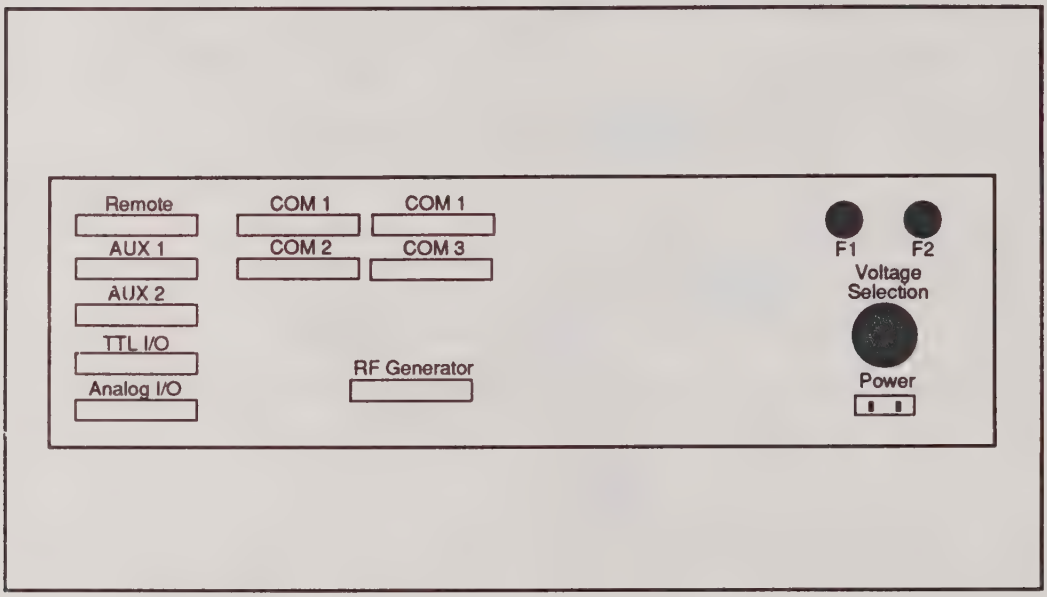


Figure 4-9. QualiTorr Station Controller Rear Connections

4.4.1 Single Probe QualiTorr Remote System

Reference: Figure 4-10

1. Ensure that the Station Controller is not plugged into the power source.

2. Connect the cable from the probe into the back of the Station Controller at the connector marked *RF Generator*.

3. If the optional hand-held leak detector was ordered, connect it to the front of the Station Controller at the connector prior to use. It is normally installed when it is to be used and disconnected when not in use.

4. Do not connect the 25-foot RS-485 Null Modem Cable (Part Number 04994-0025) from COM1 RS-485 DTE port on the back of the UTI Host Computer to the COM1 connector on the Station Controller at this time. This will be done in Section 4.5.

5. Proceed to Section 4.5

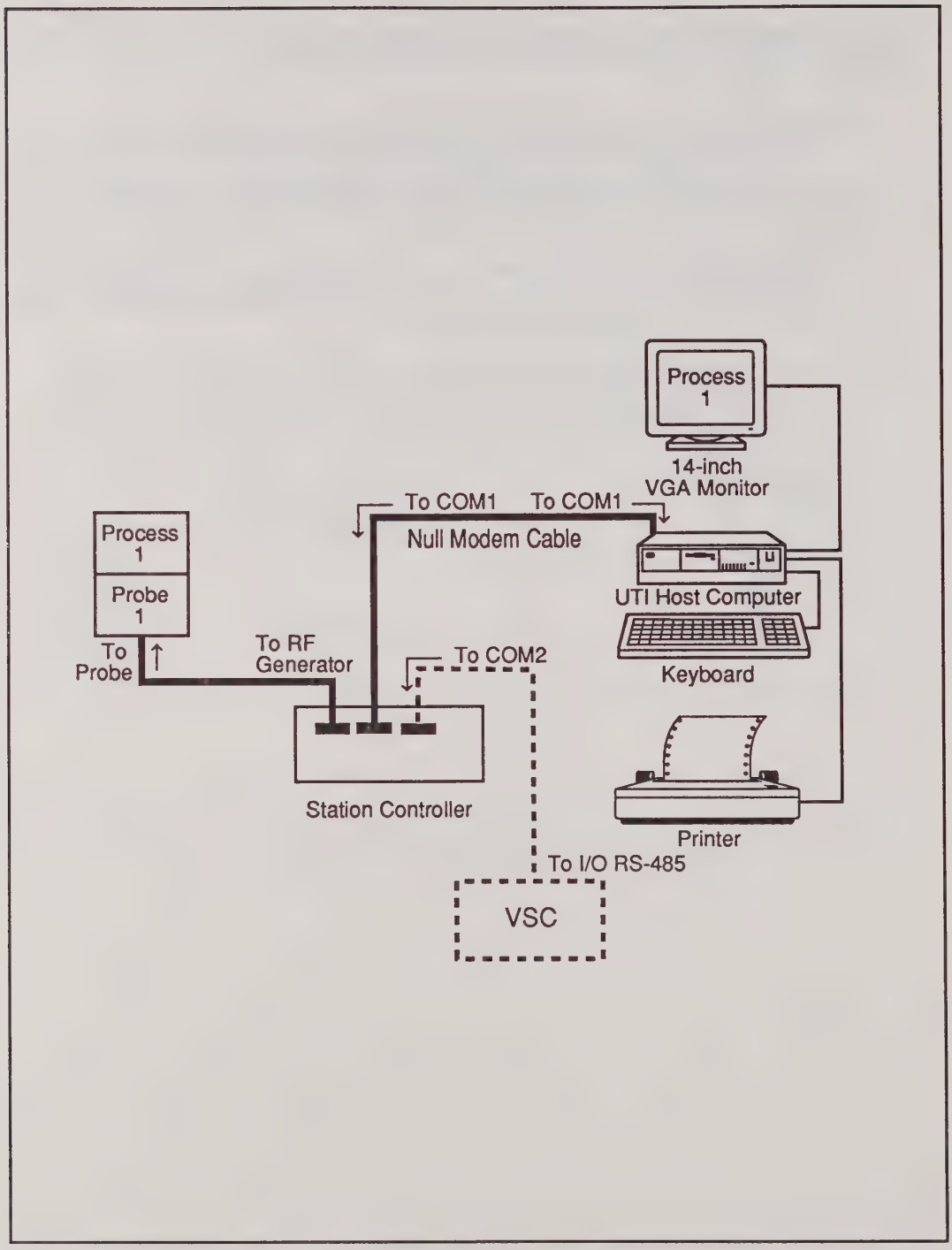


Figure 4-10. Single Probe QualiTorr Remote System with Optional VSC

4.4.2 Multiple Probe QualiTorr Remote System

Reference: Figure 4-11

1. Complete the installation of each QualiTorr Remote Module Station as explained in Section 4.4.1.

2. Complete the COM1 multi-drop RS-485 network as shown in Figure 4-11. The 10-foot multi-drop cables are Part Number 05309-0010.

> **Caution**
>
> **It is important to note that the RS-485 Null Modem Cable (25 feet) is not interchangeable with the multi-drop cables (10 feet). The connectors are the same, but the cables are wired differently. Confirm lengths and part numbers prior to installation.**

3. Do not connect the 25-foot RS-485 cable (Part Number 04994-0025) from COM1 RS-485 DTE port on the back of the UTI Host Computer to the COM1 connector on the QualiTorr Remote Control Module at one end of the multi-drop chain at this time. This will be done in Section 4.5.

4. Proceed to Section 4.5.

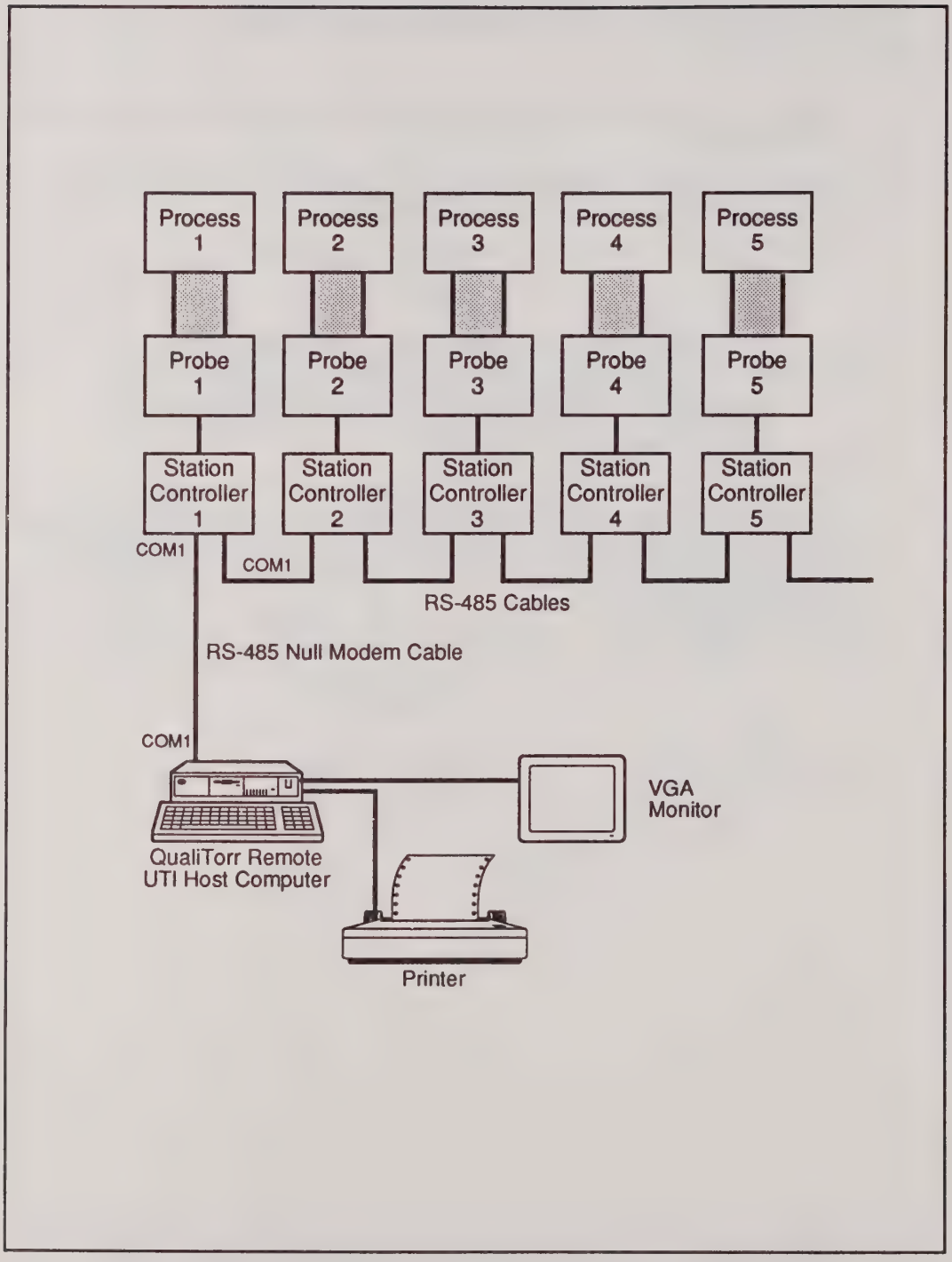


Figure 4-11. QualiTorr Remote System Parallel Multiplexing (ParaMux)

4.4.3 Multiple Probe Configuration with an OEM Host Computer

Reference: Figure 4-12

1. Complete the installation of each Station Controller as explained in Section 4.4.1.

2. Complete the COM1 multi-drop RS-485 network as shown in Figure 4-12. The 10-foot multi-drop cables are Part Number 05309-0010.

> **Caution**
>
> **It is important to note that the RS-485 Null Modem Cable (25 feet) is not interchangeable with the RS-485 multi-drop cables (10 feet). The connectors are the same, but the cables are wired differently. Confirm lengths and part numbers prior to installation.**

3. Do not connect the 25-foot RS-485 Null Modem Cable (Part Number 04994-0025 not supplied) from the RS-485 DTE port on the back of the OEM Host computer to the COM1 connector on the QualiTorr Remote Station Controller at one end of the multi-drop chain at this time. This will be done in Section 4.5. A schematic for the RS-485 Null Modem Cable is included with the schematics in Chapter 12.

4. Contact your UTI representative for additional installation information.

5. Proceed to Section 4.5.

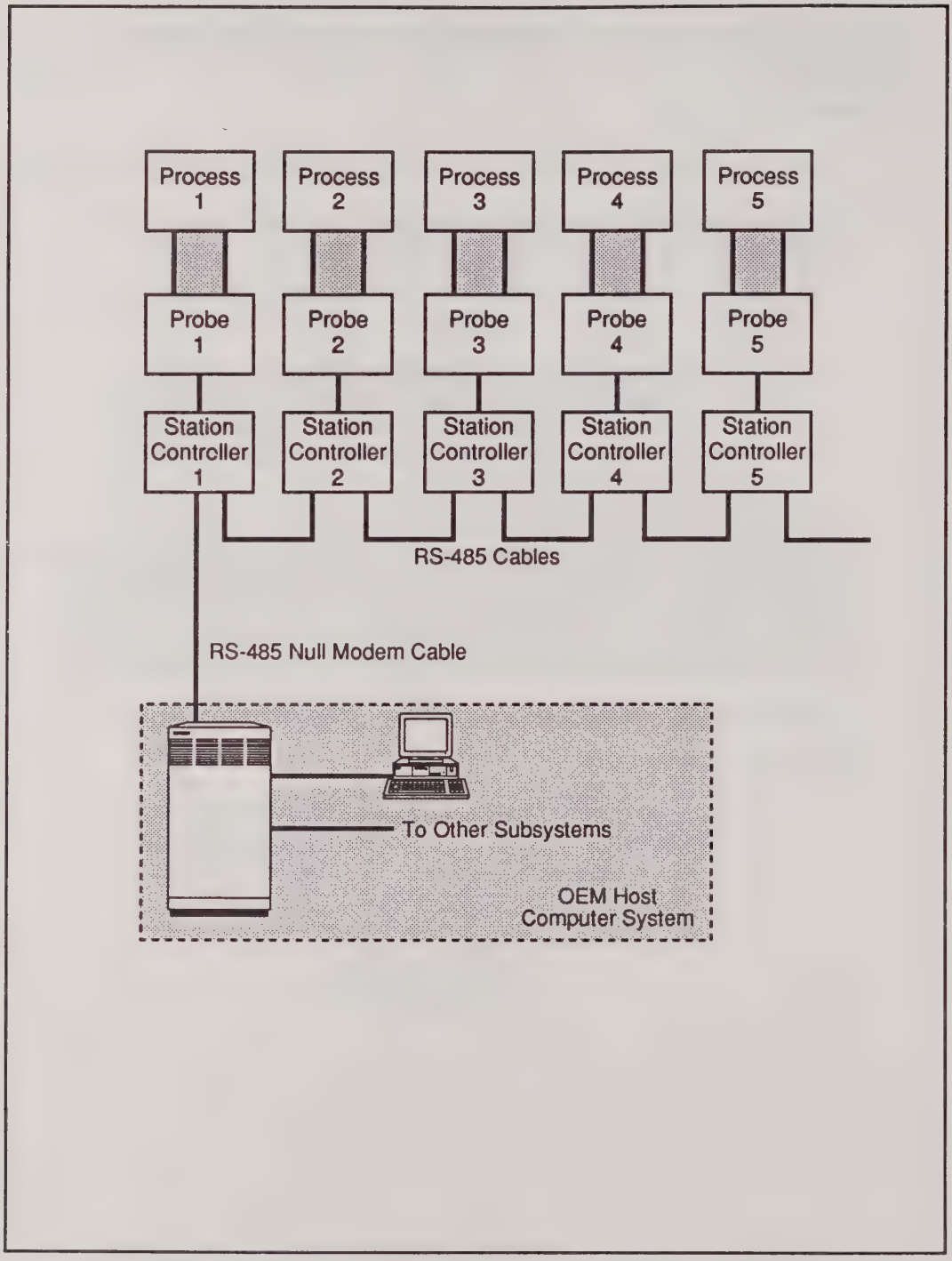


Figure 4-12. Multi-probe Configuration with OEM Host Computer Control OEM Parallel Multiplexing (ParaMux).

4.5 QualiTorr Remote System Checkout

Checkout of the QualiTorr Remote System consists of the following two steps:

1. Local Mode System Checkout (Section 4.5.1)
2. Host Computer Mode System Checkout (Section 4.5.2)

4.5.1 Local Mode System Checkout

Local Mode Software is used with the Station Controller for first time start-up and maintenance. This is because the QualiTorr Remote Host Computer Software automatically brings the filaments on Hot. Local Mode software provides the user with the ability to see the data at the Station Controller.

Local Mode System Checkout of a Remote Station consists of pumping the system down, booting the Station Controller in Local Mode, and turning the Station Probe filaments On for the first time.

In order to conduct the Local Mode System Checkout, the installer must operate the Station Controller in Local Mode. The Host Computer's Null Modem Cable is disconnected from the first Station Controller during this procedure. Temporarily turn to Section 8.1.1 and attach the VGA Monitor and AT keyboard to the front of the Station Controller as shown in Figure 8-1.

To checkout each QualiTorr Station (Station Probe and Station Controller), follow these steps:

1. Insert the QualiTorr Remote Local Mode Software diskette into the Station Controller. The label on the diskette reads "QualiTorr Remote - Local QualiTorr III Simulation."

2. Turn the power *On* to the Station Controller. The Station Controller will boot using the Local Mode Software. Local Mode operation is provided using keyboard Function Keys F1 through F6 corresponding to the screen displayed on the VGA monitor, as shown in Figure 8-2 and described in Section 8.1.1.

3. Use the QualiTorr Short Manual Instructions for Maintenance and Calibration in Appendix D and conduct the procedures described under the section titled *Initial Start-up Conditions* (Section I) followed by Programmable Scan (Section IVA under Utilities).

4. Programmable Scan provides the operator with an excellent means of checking the performance and operation of each Remote Station. When using Programmable Scan with Local Mode software, it is necessary to use Function Keys F1 through F6 to choose the functions displayed on the vertical, right hand margin of the monitor. See Figure 8-2.

5. Select an AMU number for a gas that is known to exist in the sampling system. For example, if nitrogen is chosen, the *center* of the scan should be selected to be 28 AMU and the *scan width* should be chosen to be 13 AMU. If everything is operating properly, you should see the 28 AMU peak displayed with a white and orange vertical line passing through the center of the peak.

6. Conduct a System Calibration for Remote Station #1 using the procedure given in Section II of the Maintenance and Calibration portion of the QualiTorr Short Manual Instructions. This document is found in Appendix D. (Note that Calibration will be repeated later in the Host Computer Mode so that the Remote System Calibration values will be stored on the Station #1 Remote Station Controller diskette.)

7. Operation in the Programmable Scan also provides the opportunity to check the resolution for each Station Probe. (If the Station Probe needs adjustment, perform the High and Low Mass Resolution Adjustments in Section 6.10 of this manual.

8. Repeat Steps 1 through 7 for each QualiTorr Remote Station. When all Remote Stations have passed preliminary checkout, proceed to Step 9.

9. When all of the QualiTorr Remote Stations have been checked using Local Mode, the Host Computer is connected to Station #1 with a Null Modem Cable. Final checkout is conducted in Host Computer Mode. Proceed to Section 4.5.2.

4.5.2 Host Computer Mode System Checkout

Reference: QualiTorr Host Computer Operating Instructions, Appendix E.

Host Computer Software pre-loaded onto the Host's Hard Disk is used with the Host Computer for the final checkout. A QualiTorr Remote System Disk is required in each Station Controller. Note that the software is Station Probe-specific. This means that the System Disk for Station #1 will work properly in only Remote Station #1. **Do Not Mix-up the System Disks.**

1. Ensure that the vacuum system is pumped down.

2. Connect the Host Computer to the first Station Controller using a 25-foot Null Modem Cable (Part Number 04994-0025). Insert the diskette labeled "QualiTorr Remote System Disk Station #1 into Station Controller #1. Turn *On* the Station Controller. Note that the filaments will automatically come *On*.

> **CAUTION**
>
> **The QualiTorr Remote Station Controller Software automatically brings the filaments *On* Hot! Ensure that a vacuum is present before booting the Station Controller Software!**

3. Turn the Host Computer *On*. It will boot from the hard disk to the *Monitor Mode*. Select *Change Mode* to access the *Process Mode*. All of the QualiTorr Remote's functions and features are available in *Process Mode*. At this point the operator should refer to the QualiTorr Remote Host Computer Manual's instructions that are located in Appendix E.

4. Select *Network* from the *System* Menu and a Network Dialog Box will appear. Choose the Remote Station(s) that will be put into operation. After choosing all of the Remote Stations that you plan to use, press OK (Enter).

5. Select *Remote Status* from the Station 1 menu. If the Remote Station is communicating properly with the Host Computer, a Status Dialog will appear (within about 60 seconds). Press OK (Enter). Repeat this procedure for all Remote Stations.

6. Perform the *I. Initial Start-up Conditions* procedures given in the *QualiTorr Remote Host Computer Operating Instructions* that appear in Appendix E.

7. Perform the *II. Operation for Each Station - Calibration* procedure given in the *QualiTorr Remote Host Computer Operating Instructions* that appear in Appendix E.

8. Perform the *II. Operation for Each Station - Analog Scan* procedure given in the *QualiTorr Remote Host Computer Operating Instructions* that appear in Appendix E. Note: Analog Scan in Host Computer Mode is the same as Programmable Scan in Local Mode.

9. Perform the *II. Operation for Each Station - Dynamic Scan* procedure given in the *QualiTorr Remote Host Computer Operating Instructions* that appear in Appendix E.

10. Perform the *II. Operation for Each Station - Static Scan* procedure given in the *QualiTorr Remote Host Computer Operating Instructions* that appear in Appendix E.

11. Repeat Steps 1 through 10 for each Remote Station using the appropriate System Disk in each Station Controller. Disk #1 in Station Controller #1, Disk #2 in Station Controller #2, etc. If access to *Process Mode* is to be controlled by a password, select *Change Mode* from the *System* Menu to activate the *Program Mode Password Dialog Box*. Enter a password that will be known to all operators that are to have access to *Program Mode*. When all of the Remote Stations on the Network have been checked out, proceed to Section 4.5.3.

4.5.3 Host Computer Mode Shutdown

1. From the System Menu of the Host Computer, select *Shutdown*. All Remote Stations will be placed in Idle Mode, as required for a total System Shutdown.

2. Turn *Off* the Station Controller(s).

3. Turn *Off* the Host Computer. Proceed to Section 4.6.

4.6 QualiTorr Remote System Certification

The following Warning is provided to all users of the QualiTorr Remote System.

WARNING

Do not operate the UTI QualiTorr Remote System until it has been properly installed and certified as ready for operation using the procedures described in the QualiTorr Remote Installation and Maintenance Manual, as indicated below.

Certified

Installed and Ready for Operation

Signature: _____

Company: _____

Date: _____

At this point in the installation process, the installer should sign the above certification of the QualiTorr Remote System. This certification indicates that the System is operating properly. By signing this certification, the installer is stating that, to his or her knowledge, the QualiTorr Remote System is ready to perform the process monitoring and analyses for which it was purchased.

Chapter 5

FRU Removal and Replacement

This Chapter provides step-by-step instructions for the removal and replacement of all major Field Replaceable Units (FRUs).

5.1 Conflat Flange Gasket

To remove a Conflat flange gasket, follow these steps:

1. Remove all of the bolts holding the two flanges together.

2. Under normal conditions, the flanges will be easily separable. However, after a prolonged bakeout, the flanges may be "stuck" to the Conflat sealing surfaces. If this is the case, proceed to Step 3. If the flanges separate, proceed to Step 4.

3. To separate two stuck Conflat flanges, insert a narrow screwdriver into the leak-check groove and pry the flanges apart. Be careful to have a firm grip on the flange, especially if it is a probe flange.

4. Conflat gaskets are designed to expand radially until their outside edge locks in the flange counter-bore. Under normal conditions, the gasket will be easily removable using a clean plastic, rubber, or nylon gloved-hand. However, after prolonged bakeout, the gasket may be "stuck" to the Conflat sealing surfaces. If this is the case, proceed to Step 5. If the flanges separate, proceed to Step 6.

5. To remove a stuck gasket, **Do Not** insert a sharp pointed instrument such as an awl or scriber into the leak-check groove and under the gasket. For extra safety when removing the probe's Conflat flange gasket, use a pair of end-cutter pliers in the leak-check groove to grab and hold onto the gasket while it is being removed. This method of removal minimizes the possibility of the removal tool slipping and causing damage to the delicate probe. Avoid hitting the sealing edge of the flange.

6. Discard the old gasket; it should not be reused.

To replace a Conflat flange gasket, follow these steps:

1. Put on a pair of clean plastic, rubber, or nylon gloves.

2. Never assume that a new (previously unused) gasket is clean. Clean the gasket using the procedures given in Section A.3. Place the clean new gasket between the two flanges. The gasket will fit into the step of each flange and provide axial alignment.

3. Insert screws through both flanges. Washers are used with all flanges over 2.75-inch OD.

4. Unlubricated stainless steel surfaces will gall, especially when baked. To prevent galling, apply a small amount of high temperature lubricant to the screw threads.

5. Attach the nuts and tighten each one in turn using approximately 5 to 8 ft-lbs of torque. This will partially close the gap between the flange faces.

6. Repeat the sequential tightening two more cycles around the bolt circle.

7. The copper gaskets are partially sheared in making the seal. The bolts should be tightened until the flange faces meet. The maximum torque required for a leak-free seal is 16 ft-lb for the 2.75-inch OD flange. For larger flanges, a maximum torque of 26 ft-lbs is sufficient.

5.2 Pressure-Reduction Orifices

It is important to note that Orifices cannot be reused. Do not remove an orifice unless you intend to replace it.

To remove an orifice, follow these steps:

1. Use a 9/64-inch allen wrench to remove the six allen screws holding each Conflat flange together. Remove both Conflat flanges. See Section 5.1 for the recommended gasket removal procedure.

2. The orifice is located in the section of tubing that is closest to the probe.

3. If the size of the orifice is to be changed, remove the old tag indicating the old pressure-reduction orifice diameter.

To replace an orifice, follow these steps:

1. Replace the old orifice with the new orifice. Ensure that the concave side of the orifice is on the probe side of the tube and the smooth side of the orifice is on the high pressure (process chamber) side.

2. Use new 0.75-inch Conflat flange gaskets for the non-orifice fittings.

3. If the new orifice diameter is different than the original orifice, replace the old tag with a new tag indicating the new conductance orifice diameter.

5.3 Probes

5.3.1 Probe Removal

The following instructions outline the recommended maintenance procedure for the removal of the open ion source, closed ion source, and fast response quadrupole probes from their chambers. The removal procedure requires that you carefully follow the specified steps. A Probe Removal Tool (UTI P/N 02600) is available from UTI; some users find it helpful in removing the probe, but others agree that it does not allow you to feel the orientation of the closed ion source or fast response probes sufficiently to warrant its use during the probe replacement process.

To remove a probe, follow these steps:

1. Remove two screws holding the black anodized ring clamp to the 4.5-inch probe flange.

2. Remove the eight bolts holding the probe flange.

3. Firmly grasp the probe flange with both hands, and then ***very carefully and slowly*** guide the probe straight out from its chamber. Even with all eight of its securing bolts removed, the probe may still prove to be difficult to remove. It may even be necessary to *gently* rock the probe initially during this part of the removal process in order to break loose its gasket seal which may still be sticking.

> **CAUTION**
>
> **It is vitally important not to allow any radial movement of the probe flange to avoid breaking any of the nine ceramic feed-through insulators on the flange.**

4. Set the probe upright on the 4.5-inch flange. If the black anodized ring clamp has been removed, the ring fits nicely into a masking tape ring for stability. **Do Not** rest the probe on its side in a clean work area.

5.3.2 Probe Replacement

CAUTION

Replacing the probe assembly into the chamber requires a very steady and gentle touch so as to properly align the closed ionizer source with its bellows entry tube.

Failure to correctly align the ion source with the bellows tube during the replacement procedure will cause the bellows to become distorted or misaligned. Any distortion or bending of the bellows necessitates the disassembly of the chamber from the inlet so that the bellows can be straightened and properly realigned.

HELPFUL TIP

When the probe is being horizontally inserted during installation, it is possible that the gasket can fall out of its groove and onto the probe. Since both hands are being used to hold the probe, it is very difficult to recover from this situation without putting the probe down and starting this step over. This problem can be avoided by the use of a two 6-inch lengths of sticky-tape that are folded over on themselves and pressed together leaving only about 0.25-inch of exposed sticky tape on each. Lay the two 3-inch length tapes on either side of the probe flange with the new gasket facing up and adjust their positions (sticky side down) so that the sticky section attaches partially to the outside vertical edge of the gasket and partially to the horizontal flange. The tapes should stick out beyond the edges of the flange so that they can easily be grasped later in the procedure. **Do Not Allow The Tape To Cross Or Come In Contact With The Exposed Face Of The Gasket.** These sections of tape will hold the gasket to the flange while the probe is being manipulated into position during the insertion procedure. After the probe has been inserted and is loosely in place, these protruding handles are pulled out and away and discarded, leaving the gasket in position for inserting the bolts in the Conflat flange and completing the seal.

5.3.2.1 Open Ion Source Probe

1. Clean the probe flange and new gasket using the procedures given in Section A.3. Position the probe so that it is vertical (connections down) and place the new, clean gasket in the Conflat flange.

2. Pickup the probe by the Conflat Flange and carefully position the probe at the entrance of the vacuum chamber. Then, very slowly and gently guide it into its manifold/chamber. Keep the probe moving into the chamber on axis and avoid hitting the side of the chamber with the delicate feed-thrus on the probe flange.

3. Once the probe is seated in its chamber, align the holes in the Conflat Flanges and reinstall the eight bolts that hold the probe flange.

5.3.2.2 Closed Ion Source Probe

Reference: Figure 5-1

1. Clean the probe flange and new gasket using the procedures given in Section A.3. Position the probe so that it is vertical (connections down) and place the new, clean gasket in the Conflat flange.

2. Pickup the probe by firmly gripping the outside of the probe's Conflat Flange and carefully position the probe so that the holes in the probe support tube face the system turbomolecular pump (TMP). Then,very slowly and gently, guide the probe into its sampling manifold/chamber. Be sure that the closed ion source is kept centered inside the chamber until a very slight resistance is felt. Upon reaching this point, stop all of its forward movement. There should be about 1/8 to 1/4-inch distance remaining between the flanges when the resistance is felt.

3. Any slight resistance encountered means that the probe has contacted the ion source entry tube or bellows (see Figure 5-1). This is the single most critical point in the probe replacement procedure. Extreme care must be taken to ensure the proper entry of the sampler's ion source entry tube **into** the center of the probe's ion source insulator (see Figure 5-1).

4. Gently "wiggle" the end of the probe while guiding it very slowly forward into the chamber. If the probe and ion source are both properly aligned, then the probe should be able to slide completely into the chamber. If resistance to the insertion of the probe is felt, then the probe should be completely removed and a visual inspection performed (see Step 5). If the probe is now in place, proceed to Step 7.

5. A visual inspection should reveal if bellows tube is misaligned or not. Recheck the ion source guide for any evidence of particles that might have hindered this replacement. If the bellows tube appears to be misaligned, proceed to Step 6. If the bellows tube is straight, repeat Step 4.

6. In the event that the ion source entry tube or bellows has become misaligned, the following procedure must be observed to straighten or realign it before the probe can be remounted into its chamber.

   a. Remove the probe chamber from the inlet (or remove the inlet from the probe chamber, depending on the vacuum/process system configuration). This task can be accomplished easier with the system on the bench.

   b. Straighten or align the ion source entry tube visually, so it is on its axis, and so that the end of the tube is approximately 1.2 inches from the 2.75-inch flange mounting surface.

   c. Install the probe into the chamber so as to position it with the holes in its support tube facing towards the system turbomolecular pump (TMP).

   d. Reinstall the inlet onto the probe chamber using a new gasket. The ion source entry tube or bellows can now be installed into the ion source.

   e. Proceed to Step 7.

7. Once the probe is seated in its chamber, reinstall the eight bolts of the probe flange.

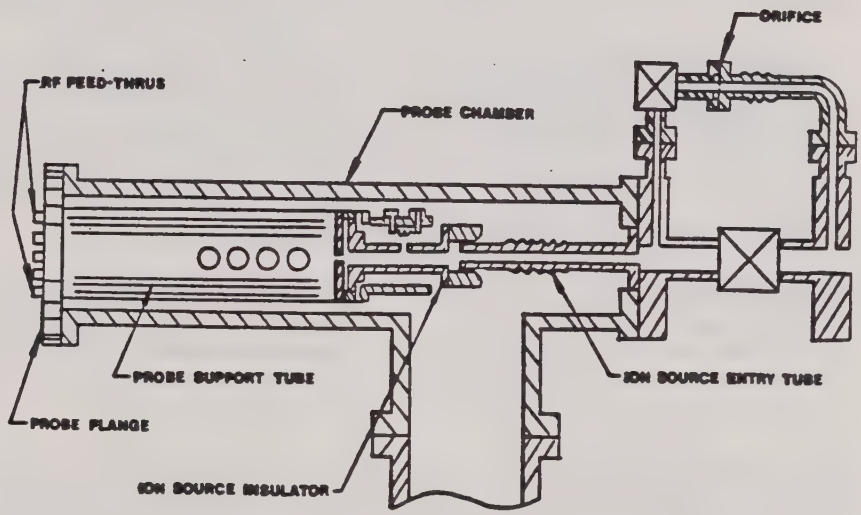


Figure 5-1. Closed Ion Source Probe Cut-Away View

5.3.2.3 Fast Response and Short Probes

Reference: Figures 5-2 and 5-3

1. Clean the probe flange and new gasket using the procedures given in Section A.3. Position the probe so that it is vertical (connections down) and place the new, clean gasket in the Conflat flange.

2. Use a flashlight to view inside the fast response sampler chamber and note the orientation of the pressure-reduction orifice fitting that the probe will be inserted into. The round coupling fitting naturally moves to the bottom of the fitting when the probe is removed. This necessitates that the probe be oriented very slightly down as it is inserted so that the probe properly inserts into the orifice fitting.

3. Pickup the probe by firmly gripping the outside of the probe's Conflat flange and carefully position the probe in the center of the entrance of the chamber's flange Then,very slowly and gently, guide the probe into its sampling manifold/chamber. Be sure that the probe's end tip is kept slightly below center inside the chamber until a very slight resistance is felt. Upon reaching this point, stop all of its forward movement. There should be about 1/8 to 1/4-inch distance remaining between the flanges when the resistance is felt.

4. Any slight resistance encountered means that the probe has contacted the pressure reduction orifice fitting (see Figures 5-2 and 5-3). This is the single most critical point in the probe replacement procedure. Extreme care must be taken to ensure the proper entry of the probe's tip into the center of the pressure-reduction orifice fitting (see Figures 5-2 and 5-3).

5. Gently "wiggle" the end of the probe while guiding it very slowly forward into the chamber. If the probe and ion source are both properly aligned, then the probe should be able to slide completely into the chamber. If resistance to the insertion of the probe is felt, then the probe should be completely removed and a visual inspection performed (see Step 5). If the probe is now in place, proceed to Step 7.

6. A visual inspection should reveal if the probe is misaligned or not. Recheck the probe and receiving fitting for any evidence of particles that might have hindered the probe's replacement.

7. Once the probe is seated in its chamber, reinstall the eight bolts of the probe flange.

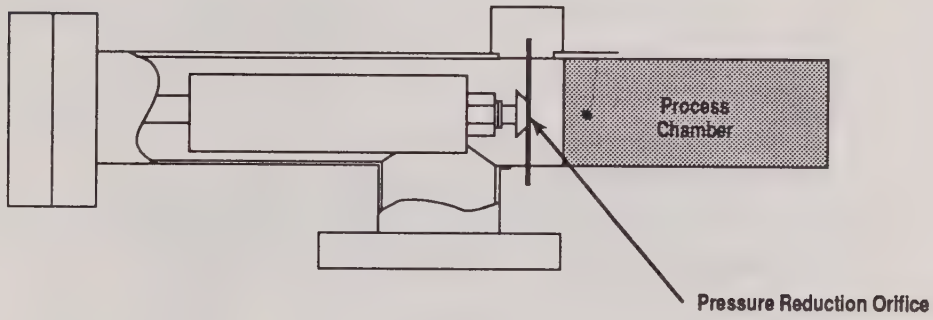


Figure 5-2. Fast Response Probe Cut-Away View

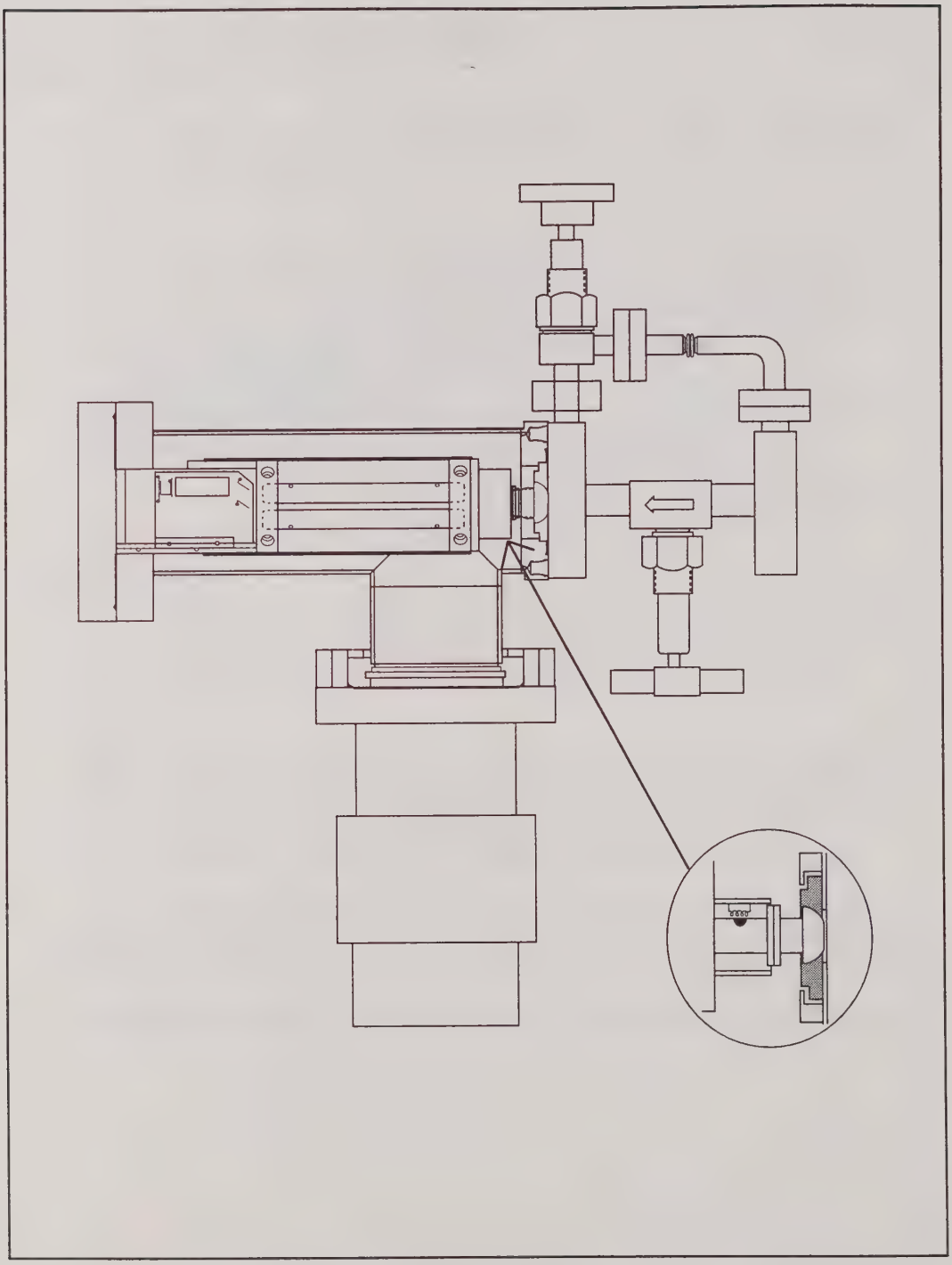


Figure 5-3. Short Probe

5.4 Ionizer Filaments

Reference: Figures 5-4 (Open Ion Source) and 5-5 (Closed Ion Source)

The ionizer filaments for the QualiTorr Remote probe are mounted on a cylindrical reflector assembly ring which is easily removed from the ionizer assembly. The individual filaments are not specified on any parts list, instead ionizer filaments are available only as a complete cylindrical reflector assembly which must be changed. This is because of the criticality of their alignment with the holes in the ion chamber, and the fact that they are attached to the reflector assembly under optimal factory conditions.

To remove the ionizer filaments, follow these steps:

> **CAUTION**
>
> **You must wear plastic. rubber, or nylon gloves at all times to prevent oils and other chemicals from being transferred from your hands to any of the probe components.**

1. Remove the probe using the procedure given in Section 5.3. Position it vertically so that it can be worked on conveniently in a clean environment.

2. If the filaments are to be re–used, or if a new reflector is being installed, care must be taken when removing the reflector up over the ion chamber and gas coupling ceramic because of the close tolerances. To remove the open ion source filament assembly from the probe, proceed to Step 3. To remove the closed ion source filament assembly proceed to Step 4.

3. Unloosen, but do not remove, small screws 1 and 2 that are accessible from the side of the assembly. **Do not remove any other screws or nuts.** Carefully remove the open ion source filament assembly. Reference: Figure 5-4.

4. First remove the closed ion focus assembly by removing screw 1. Then, remove screws 2 and 3. **Do not remove any other screws or nuts.** Carefully remove the closed ion source assembly. Reference: Figure 5-5.

5. Once the filament assembly is removed, the ion chamber must be cleaned before reinstalling it or replacing it. UTI recommends using a clean "Pink Pearl" or "Red Star" eraser for those surfaces closest to the ionizer filaments where most of the discoloration and contamination is most likely to be found. **Be absolutely sure NO rubber is left on the ionizer parts!** Use clear bottled gas and press to remove.

A wooden toothpick, or sharpened Q–Tip stick is excellent for removing any foreign material from the two apertures opposite the filament location. This is especially important if the filaments have been oxidized, and/or the inside diameter of these apertures are coated. The eraser cleaning must be followed by a propanol or acetone and methanol rub and rinse. Coated, badly contaminated, or broken ceramic shoulder washers used to attach it to the focus plate should also be cleaned and/or replaced.

To replace the ionizer filaments, follow these steps:

1. To replace the ionizer filaments in the open ion source assembly, proceed to Step 2. To replace the ionizer filaments in the closed source assembly, proceed to Step 3.

2. Insert the two pins protruding from the open ion source filament assembly into the two holes in the open ion source assembly and carefully push the assembly down onto the source assembly Note that the pins are not symmetrically and directly across from each other. This design ensures that the filament assembly is positioned correctly in the source assembly. Confirm that the filament assembly is correctly oriented by referencing Figure 5-4. Then, tighten screws 1 and 2. Proceed to Step 4.

3. Carefully position the closed ion filament-reflector assembly over the closed ion source and down onto the contacts. Replace screws 2 and 3 and check to ensure that each filament bisects the two alignment holes. Then, replace the closed ion focus assembly by attaching with screw 1. Reference: Figure 5-5. Proceed to Step 4.

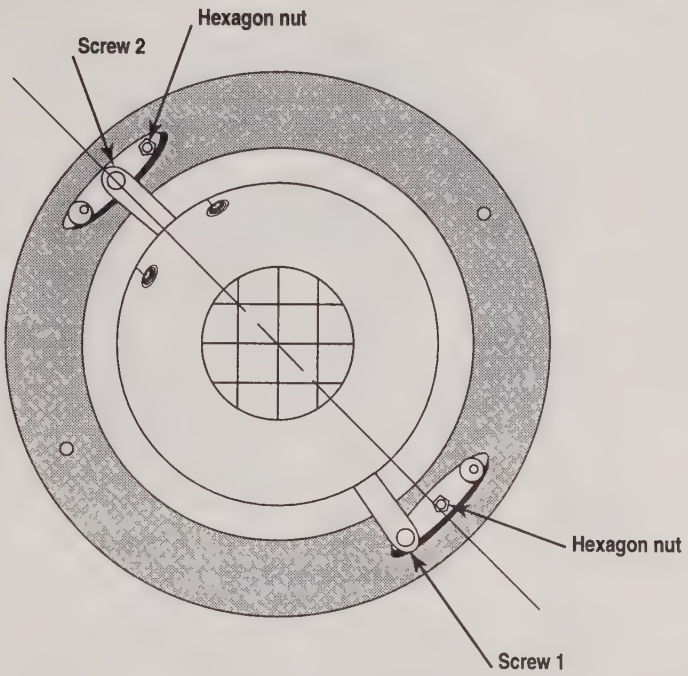
4. Check to ensure that all the screws, nuts, and bolts are securely tightened before reinstalling the probe. Remember that the gas inlet tube must be exactly on axis (visually check for proper centering) before reinserting the probe into its vacuum chamber.

4. Finally, double check the filament alignment by visually checking to see that **the filaments exactly bisect the alignment hole in the reflector and the grid aperture**.

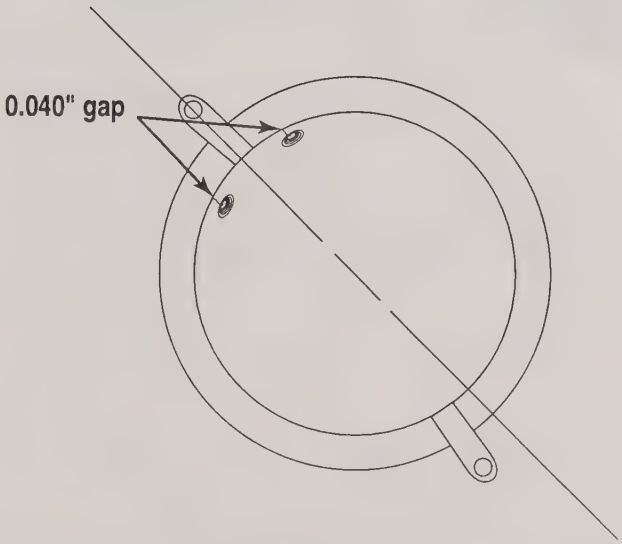
After installing the new ionizer filaments, follow these steps:

1. **Before turning the electronics on**, turn the emission POT on the control board to zero (full **clockwise**). See Figure 6-3.

2. After turning the electronics on, turn the emission POT **counter-clockwise** over **5 minutes'** time to full 0.3 ± 0.1 VDC (0.3 ± 0.1 mA) for a closed source or 2.0 ± 1.0 VDC (2 ± 1 mA) for an open source on the Ionizer Board. Measure the voltage between TP2 and TP8 on the Ionizer Board. See Figure 6-2. Note: These values for emission are approximate, and are adjusted for optimum performance for each instrument.



Open Ion Source Assembly



Open Ion Source Reflector Assembly

Figure 5-4. Open Ion Source Assembly (I)

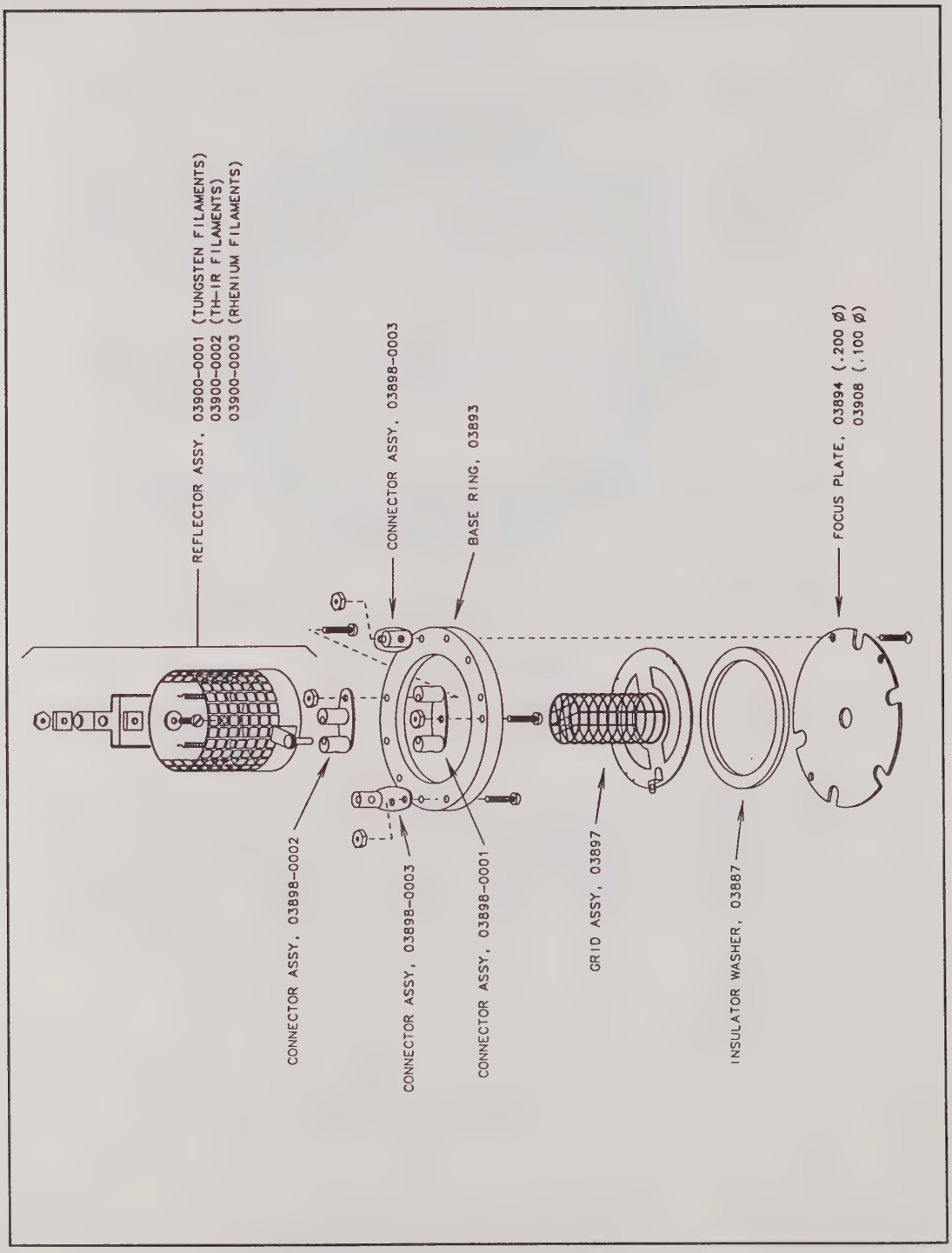


Figure 5-4A. Open Ion Source Assembly (II)

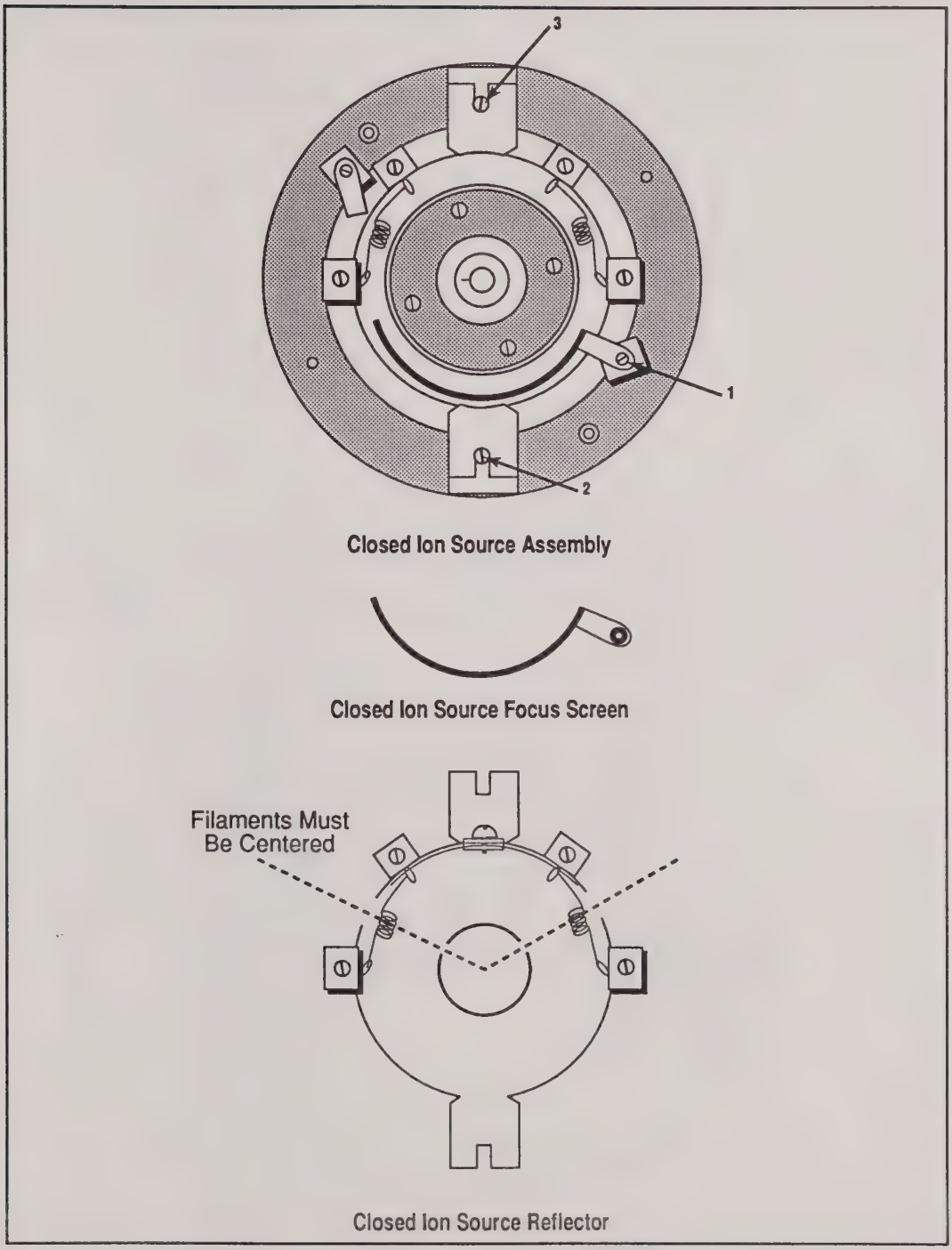


Figure 5-5. Closed Ion Source Assembly (I)

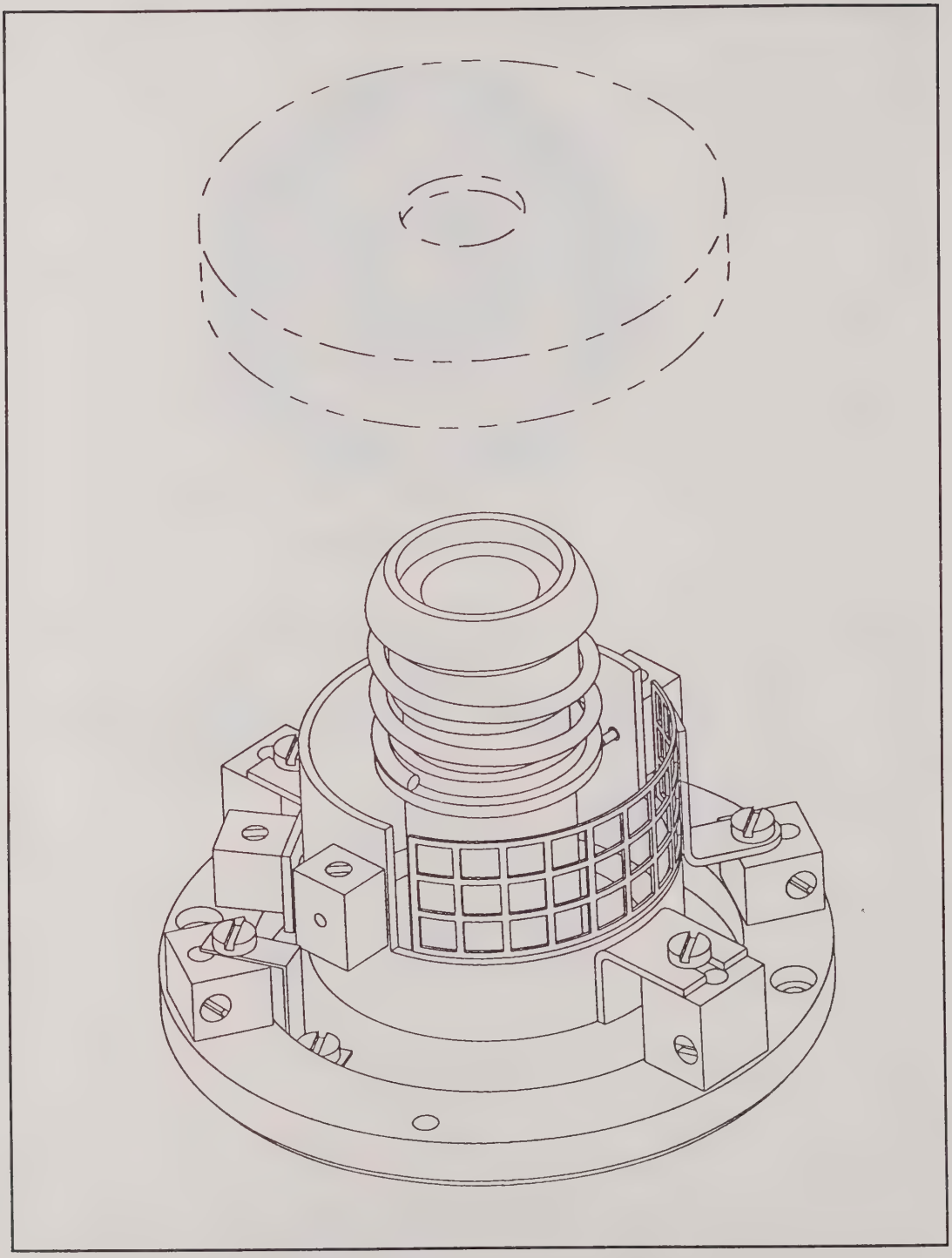


Figure 5-5A. Closed Ion Source Assembly (II)

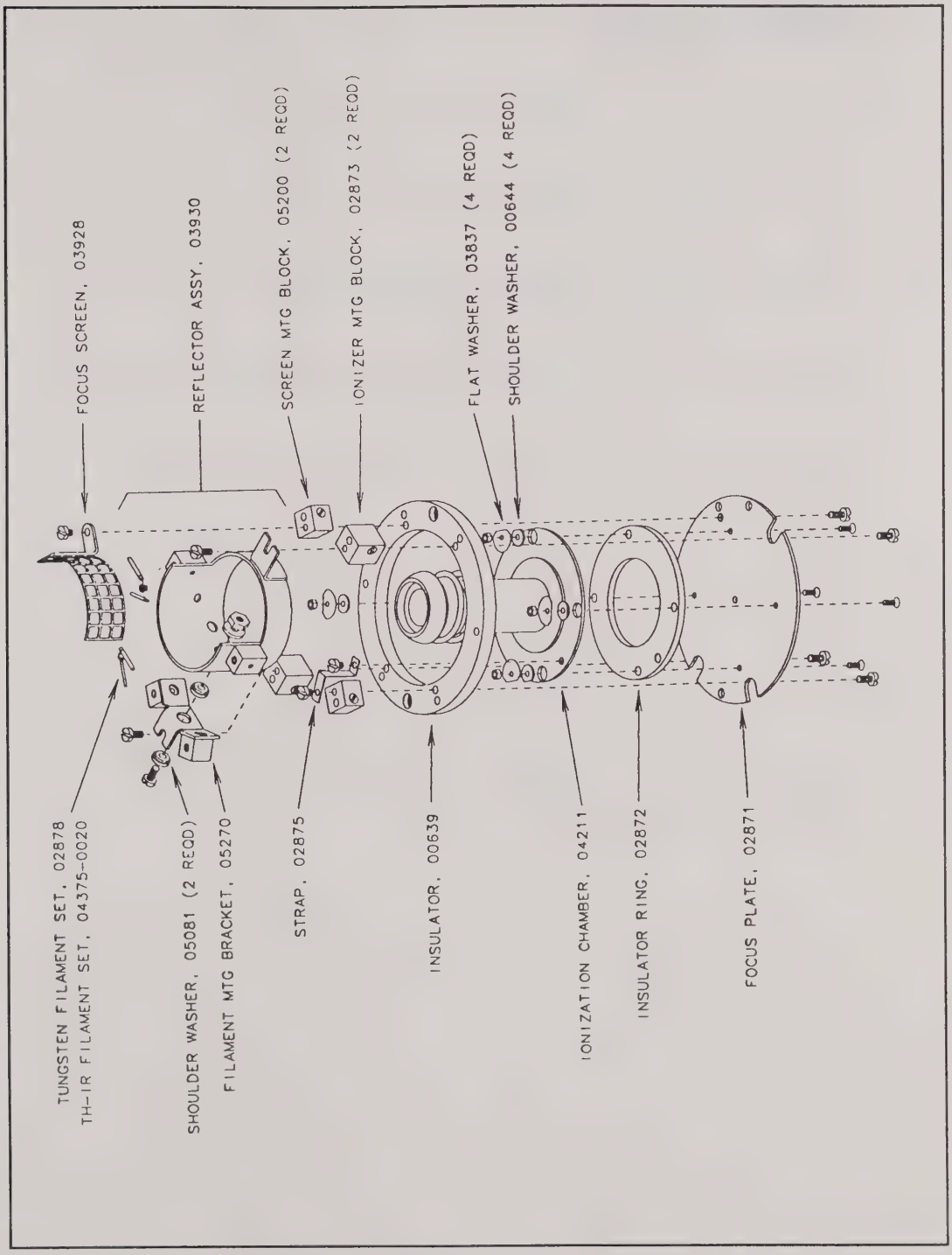


Figure 5-5B. Closed Ion Source Assembly (III)

5.5 Electron Multiplier

Reference: Figures 5-6 and 5-7

To remove the electron multiplier, follow these steps:

1. Remove the four truss head screws, 1, 2, 3, and 4, at the base of the main support tube and remove this tube. Reference: Figure 5-6.

2. Remove the 1-inch long screw that passes through the bottom filter ceramic and attaches to the nut plate on the electron multiplier cover. (Do not remove *both* 1-inch long screws found at the filter base). Reference: Figure 5-7.

3. Loosen the remaining eight truss head screws, 5, 6, 7, 8, 9, 10, holding the electron multiplier cover. Screws 11 and 12 must be removed. Carefully remove the cover. Reference: Figures 5-6 and 5-7.

4. Loosen the three set-screws holding the leads directly below the electron multiplier. These leads will have to be bent gently in order to be removed from the set screw holders. Reference: Figure 5-7.

5. The electron multiplier is held in place with two screws which pass through the vertical end plate.

6. Remove the screws and lift out the electron multiplier.

To replace an electron multiplier, follow these steps:

1. Check to ensure that a reasonable clearance exists between the multiplier's leads and the other components of the electron multiplier itself.

2. Reverse the removal procedure.

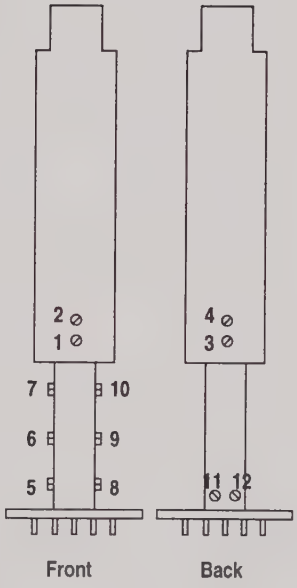


Figure 5-6. Electron Multiplier Access Screws

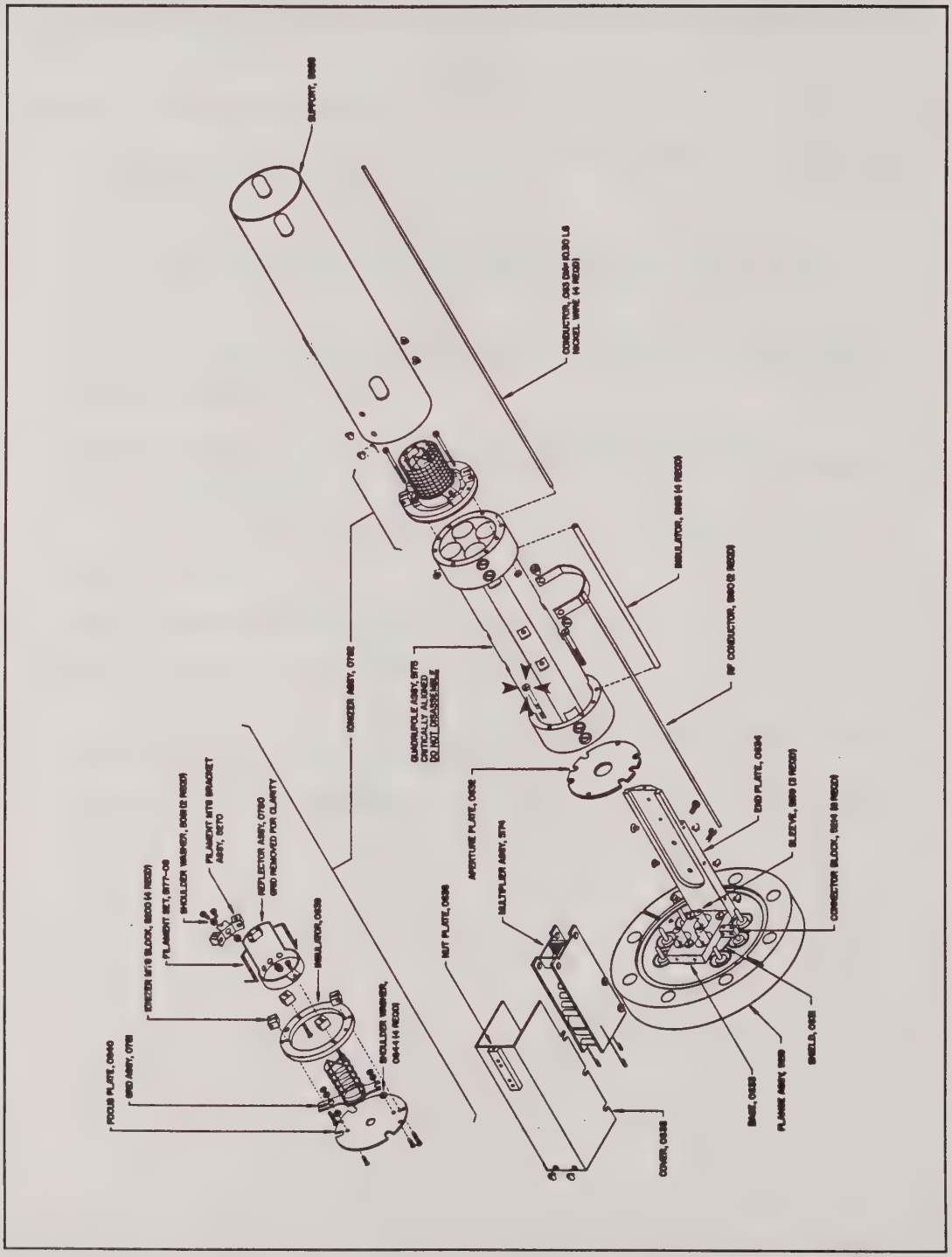


Figure 5-7. Probe Assembly (Open Ion Source Shown)

5.6 Mechanical Pump

To remove the roughing pump, follow these steps and reference Figure 4-2:

1. Close the foreline valve between the mechanical pump and the metal vacuum hose.

2. Turn off the mechanical and turbomolecular pumps. Disconnect the mechanical pump power cord from the source power.

3. Remove Clamp C and break the vacuum by disconnecting the ball valve-to-molecular sieve trap fitting.

4. Place aluminum foil, a lintless cloth, or some other material over the vacuum fittings to prevent dust and dirt from entering the vacuum components.

To replace the mechanical pump, reverse the removal procedure.

5.7 Turbomolecular Pump

To remove the turbomolecular pump, follow these steps and reference Figure 4-2:

1. Close the sampler inlet valves and the valve located between the mechanical pump and the metal vacuum hose.

2. Turn off the mechanical and turbomolecular pumps. Disconnect all power and electrical connections to the pump and bring the system up to atmospheric pressure. Use dry nitrogen or air, if available.

3. If your TMP has water-cooling, turn off the water and remove the two water lines connected to the base of the pump. Drain the water from the hoses before setting aside.

4. Remove Clamp E and disconnect the metal vacuum hose from the TMP.

5. Remove the Conflat flange that attaches the TMP to the Sampling system. See the procedure on removing Conflat flanges in Section 5.1.

6. Cover the exposed sampler system with aluminum foil, a lintless cloth, or some equivalent cover to prevent contamination of the high vacuum system.

To replace the turbomolecular pump, reverse the removal procedure.

5.8 RF Generator

To remove the RF generator, follow these steps:

1. Unclip the shielded RF connector and unplug the RF cable from the RF generator module.

2. Careful unscrew the large knurled ring clamp that holds the generator to the sampler, while supporting the RF generator to relieve lateral pressure on the nine MHV connectors.

3. Gently wiggle the RF generator while carefully pulling (straight out) to release the nine connectors. DO NOT twist or torque the module in any way. The connectors will become detached when the RF module has been pulled out about 0.5 inch.

To Replace the RF generator, follow these steps:

1. Align the BNC-type connectors on the RF generator with the connectors on the mounted probe. Rotate the RF generator so that the connector pattern matches. There is only one correct alignment.

2. Present the RF generator connectors to the probe connectors on-axis. DO NOT twist or torque the module in any way.

3. Gently wiggle the RF generator while carefully pushing (straight in) to attach the nine connectors.

4. While supporting the RF generator with one hand, carefully screw the large knurled ring clamp onto the threads on the probe mounting. The ring clamp should be hand-tight and firm. DO NOT use force or tools to tighten.

5. Connect the RF cable and use the two clips to hold the RF shield connector.

5.9 QualiTorr Remote Station Controller

Reference: Figure 5-8 (80286 Microprocessor)

Figure 5-8 shows a schematic of the QualiTorr Station Controller (80286 Microprocessor) with the major boards labeled to assist the user in locating the board desired. The figure shows a top view with the front of the console at the bottom of the page.

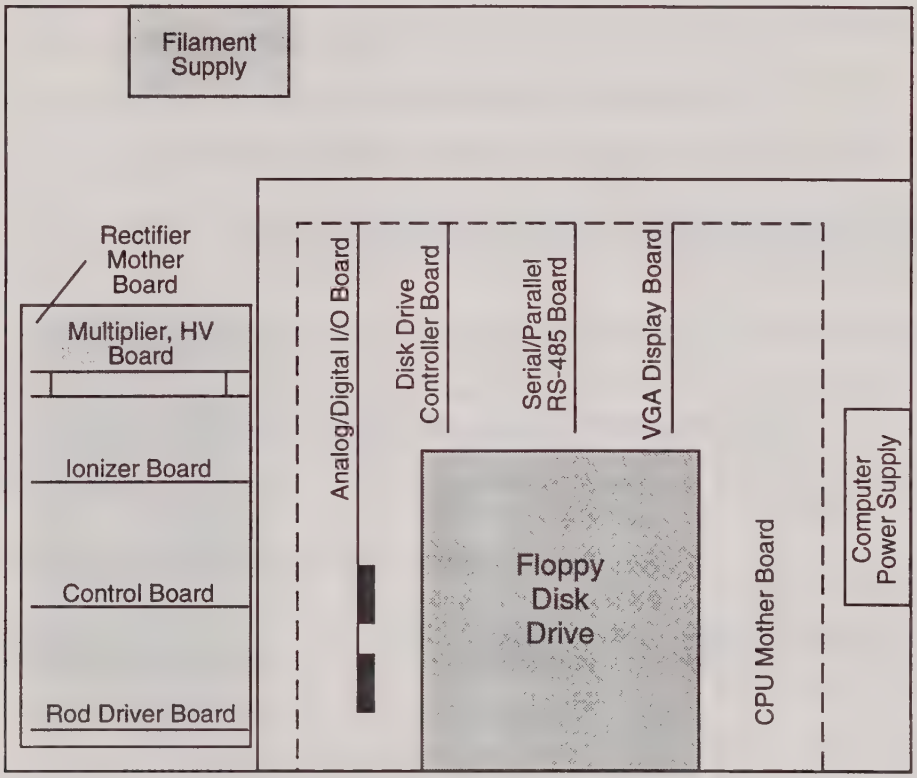


Figure 5-8. QualiTorr Remote Station Controller Board Locations

5.9.1 Enclosure Cover

To access the boards inside the control console, you must first remove the enclosure cover by following these steps:

1. Remove the screws that hold the top cover.
2. Lift off the top cover to expose the internal components.

To replace the enclosure cover, follow these steps:

1. Position the top cover on top of the enclosure.
2. Attach the top cover by inserting and tightening the cover screws.

5.9.2 Computer Power Supply (5 VDC) Board

Reference: Figure 5-8

To remove the 5 VDC Power Supply, follow these steps:

1. Disconnect all cables from the card's connectors. Label each cable and connector to ensure proper connection during the replacement procedure.
2. Loosen, but do not remove, the three bottom screws on the module from the outside of the heatsink.
3. Remove the three top screws (top row) on the inside of the heatsink on the back of the Control Console.

5.9.3 Power Supply - Filament Board

Reference: Figure 5-8

To remove the Filament Power supply board, follow these steps:

1. Remove two screws holding the power supply cover and remove cover.
1. Unplug power supply connectors.
2. Remove the two screws and two standoffs holding the power supply.
3. Remove power supply module.

5.9.4 Power Supply - Multivoltage (MVPS) Board

Reference: Figure 5-8

To remove the Multivoltage (MVPS) Power Supply, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Label, then disconnect any cables attached to the board.
5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.5 Power Supply - Electron Multiplier (3 KV) Board

Reference: Figure 5-8

To remove the Multiplier Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Label, then disconnect any cables attached to the board.
5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.6 Control Board

To remove the Control Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.

2. Remove the control console cover. See Section 5.9.1.

3. Use Figure 5-8 to locate the board from the top of the console.

4. Label, then disconnect any cables attached to the board.

5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.

6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.7 Ionizer Board

Reference: Figure 5-8

To remove the Ionizer Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.

2. Remove the control console cover. See Section 5.9.1.

3. Use Figure 5-8 to locate the board from the top of the console.

4. Label, then disconnect any cables attached to the board.

5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.

6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.8 Rod Driver Board

Reference: Figure 5-8

To remove the Rod Driver Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.

2. Remove the control console cover. See Section 5.9.1.

3. Use Figure 5-8 to locate the board from the top of the console.

4. Label, then disconnect any cables attached to the board.

5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.

6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.9 Rectifier Mother Board

Reference: Figure 5-8

To remove the Rectifier Mother Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.

2. Remove the control console cover. See Section 5.9.1.

3. Use Figure 5-8 to locate the board from the top of the console.

4. Label and remove all cables leading to the HV (3KV)/Multiplexer Board, Control Board, Ionizer Board, and the Rod Drive Board.

5. Remove the HV (3KV)/Multiplexer Board, Control Board, Ionizer Board, and the Rod Drive Board. See Sections 5.9.5, 5.9.6, 5.9.7, and 5.9.8, respectively.

6. Remove the board by removing six mounting screws.

5.9.10 Analog/Digital I/O Board

Reference: Figure 5-8

To remove the Analog/Digital I/O board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Disconnect the cable connector from the board.
5. Remove the single screw holding the board to the chassis.
6. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
7. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.11 Disk Drive Controller Board

Reference: Figure 5-8

To remove the Disk Drive Controller Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Remove the single screw holding the board to the chassis.
5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.12 Serial/Parallel RS-485 Board

Reference: Figure 5-8

To remove the Serial/Parallel RS-485 board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Remove the single screw holding the board to the chassis.
5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.13 Video Graphics Adapter (VGA) Board

Reference: Figure 5-8

To remove the VGA Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Remove the single screw holding the board to the chassis.
5. Remove the board by holding both ends of the board with the fingertips of two hands and gently pulling the board until it releases from the board connector; a rocking motion is sometimes useful.
6. Pull the board straight up and out of the console. Extreme caution should be used in handling the board, especially if static electricity is prevalent.

5.9.14 CPU Mother Board

Reference: Figure 5-8

To remove the CPU Mother Board, follow these steps:

1. Ensure that all control console power is Off and that the console's plug is removed from the source power.
2. Remove the control console cover. See Section 5.9.1.
3. Use Figure 5-8 to locate the board from the top of the console.
4. Disconnect the cables from the board and label them.
5. Remove the Analog/Digital I/O Board, Disk Drive Controller Board, Serial/Parallel Board, VGA Display Board, and the Floppy Disk Drive. See Sections 5.9.10, 5.9.11, 5.9.12, 5,9,13, and 5.9.15, respectively.
6. Detach the right side of the console by removing 8 screws. Rotate the right side down to gain access to the CPU Board.
7. Unscrew the eleven mounting screws that secure the CPU Board.
8. Gently lift the board out of the control console.

5.9.15 Floppy Disk Drive

To remove the Floppy Disk Drive, follow these steps:

1. Label all cables before disconnecting.
2. Disconnect the cables from the Disk Drive Controller Board.
3. Disconnect the power cable at the rear of the drive.
4. Remove the four mounting screws from the inside holding bracket and the four mounting screws on the front panel and remove the floppy disk drive.

5.9.16 Fuses

To remove a picofuse on the Mother Card, see Section 6.8.
To remove a fuse on other components, follow these steps:

1. Ensure that the component is turned off and that any power cords are disconnected.

2. Remove the fuse. If the fuse is held by a fuseholder, turn the fuseholder cap screw ccw using a screwdriver or coin and remove the cap. If the fuse is soldered onto a circuit board, unsolder the fuse.

3. Lift out the existing fuse and check it for continuity or visual indication of being blown.

To replace a fuse, follow these steps:

1. Ensure that the new fuse has the same ratings as the old fuse. See Table 5-1 for a summary of the fuses used in QualiTorr Remote components.

Table 5-1. Fuse Specifications

Component	Specifications
QualiTorr Remote Station Controller	100, 120, or 140 VAC, 5 A S/B 200, 220, or 240 VAC, 3 A S/B 10 A Mother Board 15 A Mother Board Rectifier Mother Board
UTI Host Computer	No external fuses
Electronic Controller* Model TCP 121	F3, 0.5 AT; F1, 2 AT F4, 0.5 AT; F2, 0.5 ASF
Electronic Controller* Model TCP 120	F1, 1.6 AT F2, 0.5 AFF
Electronic Controller Model CFF 100	115 or 100 VAC settings, 1 A 220 or 200 VAC setting, 0.5 A

2. Insert the new fuse.

3. If the fuse is held in a fuseholder, secure the fuseholder cap screw by turning it in the clockwise direction using a screwdriver or coin. If the fuse is to be mounted to a circuit board, first push the leads through the holes, then solder and clip the leads.

*These fuses are manufactured to European, not United States, manufacturing specifications. Contact your nearest Balzers representative for replacement parts.

Chapter 6

Adjustments

This chapter provides the adjustment procedures that may need to be performed to ensure optimum QualiTorr performance.

Figure 6-1A shows a top view of the station controller. Holes in the top of the cover allow access to some indicator lights, adjustment screws, and test points without cover plate removal.

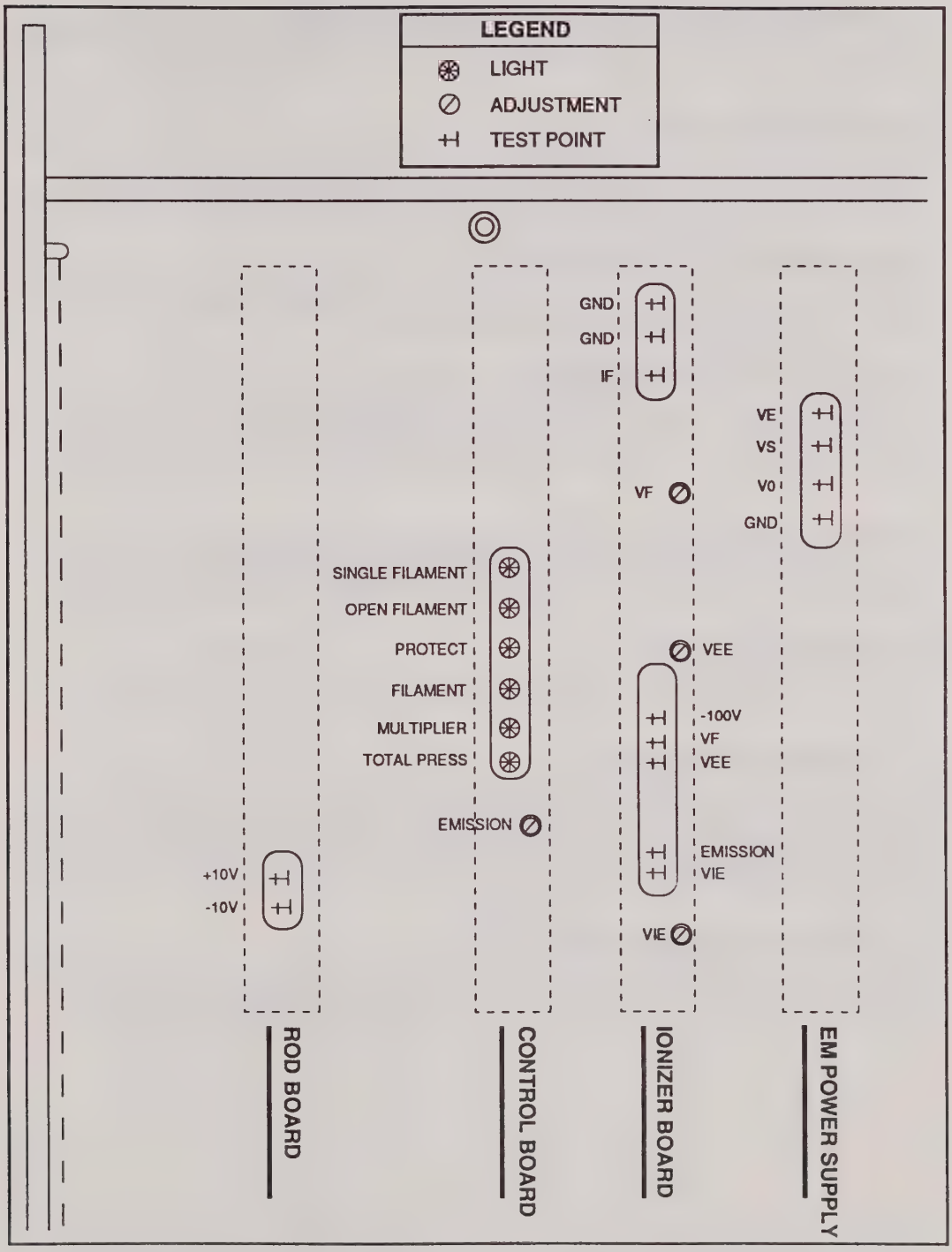


Figure 6-1A. Cover Plate Access to Some Indicator Lights, Adjustment Screws, and Test Points

6.1 Power Supply - Electron Multiplier Board

References: Figure 6-1B, Schematic 12-1A, and Assembly Drawing 12-1B.

TP1 - Q1 Emitter Voltage Test Point

This test point is used to measure the voltage on the emitter of Q1. This is the current pass element for control of the 3000 VDC power supply PS1. A reading of 5 VDC ± .1 VDC indicates that PS1 should have an output of 3000 VDC.

TP2 - Command Voltage Test Point

This test point is used to measure the control voltage (DAC output) that has been set. The voltage conversion is 10 VDC input = 3000 VDC output.

TP3 - Multiplier Voltage Test Point

This test point is used to measure the multiplier supply output voltage. A 100 megohm to 100k divider provides a 1000-to-1 reduction in output voltage. A voltage of 1.000 VDC indicates a PS1 output of 1000 VDC. A voltage of 3.000 VDC indicates a PS1 output of 3000 VDC.

If the voltage is to be adjusted manually, instead of by software, the jumper at S1 should be set to internal and R6 is the adjustment potentiometer. The adjustment potentiometer will provide 10 VDC if moved to the full CCW stop. The drive voltage should be checked at TP2.

TP4- Ground Test Point

A ground connection for all DC voltages measured on the board is provided at this test point.

S1 - Internal/External Jumper

This jumper allows the output voltage to be controlled either internally, by the system's digital-to-analog converter, or to be controlled externally. The normal jumper position is with pins 2 and 3 connected to provide *internal* control. The jumper may be moved to connect pins 1 and 2 if *external* control is required. *External* in this context means off the board.

R6 - Internal Voltage Set Potentiometer

This potentiometer controls the output voltage when the board is jumpered for *internal* control, but to adjust R6, **S1 must be jumpered to connect pins 1 and 2.** See S1 above.

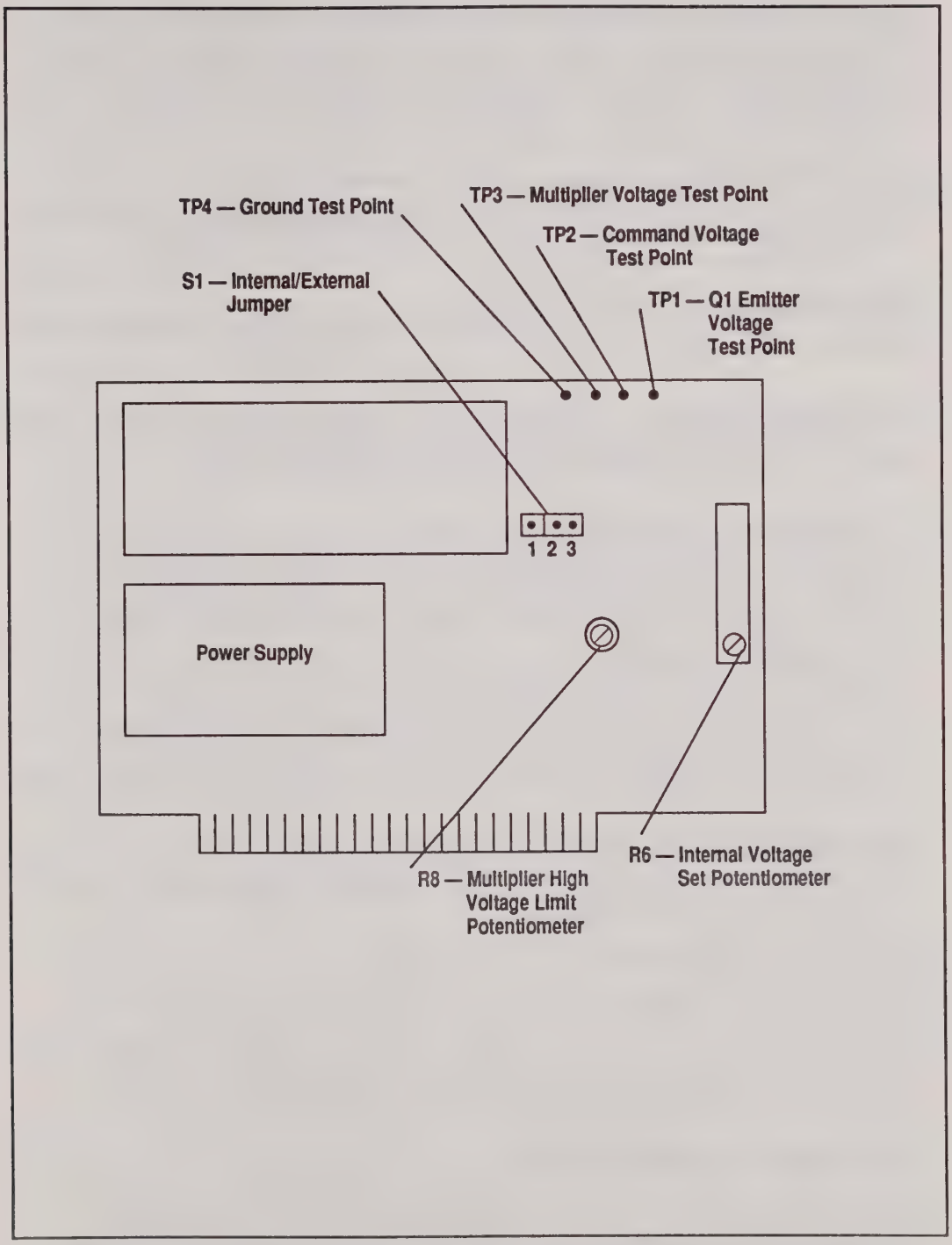

TP4 — Ground Test Point
TP3 — Multiplier Voltage Test Point
TP2 — Command Voltage Test Point
S1 — Internal/External Jumper
TP1 — Q1 Emitter Voltage Test Point
1 2 3
Power Supply
R6 — Internal Voltage Set Potentiometer
R8 — Multiplier High Voltage Limit Potentiometer

Figure 6-1B. Electron Multiplier Power Supply (3 kV) Board - Test Points and Adjustments

R8 - Multiplier High Voltage Limit Potentiometer

This potentiometer limits the high voltage output of power supply PS1 to keep it from exceeding 3000 VDC. To adjust R8, ensure that pins 2 and 3 of S1 are jumpered; then apply 12 VDC across pins 1 and 3 of J1 and set the output to 3000 VDC while reading across TP3 and TP4 (ground).

PS1 - Power Supply

This linear high voltage power supply provides 0 VDC output for 0 VDC input voltage and 3000 VDC output for 12 VDC input. The output voltage is linear over this range.

6.2 Power Supply (5 VDC) Board

No Adjustments Required.

6.3 Ionizer Board

References: Figure 6-2, Schematic 12-3A, and Assembly Drawing 12-3B.

TP1 - Voltage Ion Energy (VIE) Test Point

This test point is used to measure the voltage ion energy. The VIE voltage can be adjusted from 0 to +24 VDC, but should measure +15 (±5) VDC for an open source and +2 (±1) VDC for a closed source. See R14 for adjustment. Use TP7 or TP8 for ground.

TP2 - Emission Test Point

This test point is used to measure a voltage that is proportional to the emission current. The conversion factor is 1.0 VDC = 1.0 milliampere (mA) of current flowing through the grid. Full scale emission is 5 mA. A normal reading is 0.3 (± 0.1) VDC (0.3 ± 0.1 mA) for a closed source and 2 ±1 VDC (2 ± 1 mA) for an open source. Adjust at R39 on the Control Board.

TP3 - Faraday Cup (FC) Test Point

This test point is used to measure the Faraday Cup voltage. A zener-regulated Faraday Cup voltage of 100 ± 5 VDC is normal.

TP4 - Voltage Electron Energy (VEE) Test Point

This test point is used to measure the voltage electron energy. The voltage measured at this test point tracks the VIE supply so that the voltage across TP1 and TP4 is approximately 70 VDC, even if VIE is changed using R14. The voltage measured at this test point referenced to ground is -55 (±5) VDC for an open source and -68 (±2) VDC for a closed source. The total voltage range of this supply is 0 to -100 VDC. See R25 for adjustment. The **total** electron energy is the absolute value of VIE plus VEE.

TP5 - Voltage Focus (VF) Test Point

This test point is used to measure the filament focus supply voltage. The total voltage range of this supply is 0 to -100 VDC. A typical voltage is -20 (±10) VDC to provide optimum sensitivity at both low and high mass values. Lower voltages may result in higher sensitivity in the lower mass range, but will result in lower sensitivity in the high mass range. See R45 for adjustment.

TP6 - Current Focus (IF) Test Point

This test point is used to measure a voltage that is proportional to the focus current. For an open ion source, the conversion factor is 1.0 VDC = 0.05 milliampere (mA) of focus current. For a closed ion source, the conversion factor is 1.0 VDC = 0.01 milliampere (mA) of focus current. This voltage may vary depending on VIE, VEE, VF, and on the physical condition and geometry of the filaments. This voltage must not be higher than the emission current. No adjustment is provided.

TP7 and TP8 - Ground Test Points

All voltages for this board are referenced to the ground potential measured at either of these test points.

R14 - Voltage Ion Energy (VIE) Adjustments

This potentiometer controls the VIE voltage that is measured at TP1.

R25 - Voltage Electron Energy (VEE) Adjustment

This potentiometer controls the VEE voltage measured at TP4. To adjust R25, measure the voltage between TP1 and TP4 and adjust to 70 VDC. No provision is made for a remote DAC control.

R45 - Voltage Focus (VF) Adjustment

This potentiometer controls the focus supply voltage measured at TP5.

J2 - Voltage Ion Energy (VIE) Internal/External Jumper

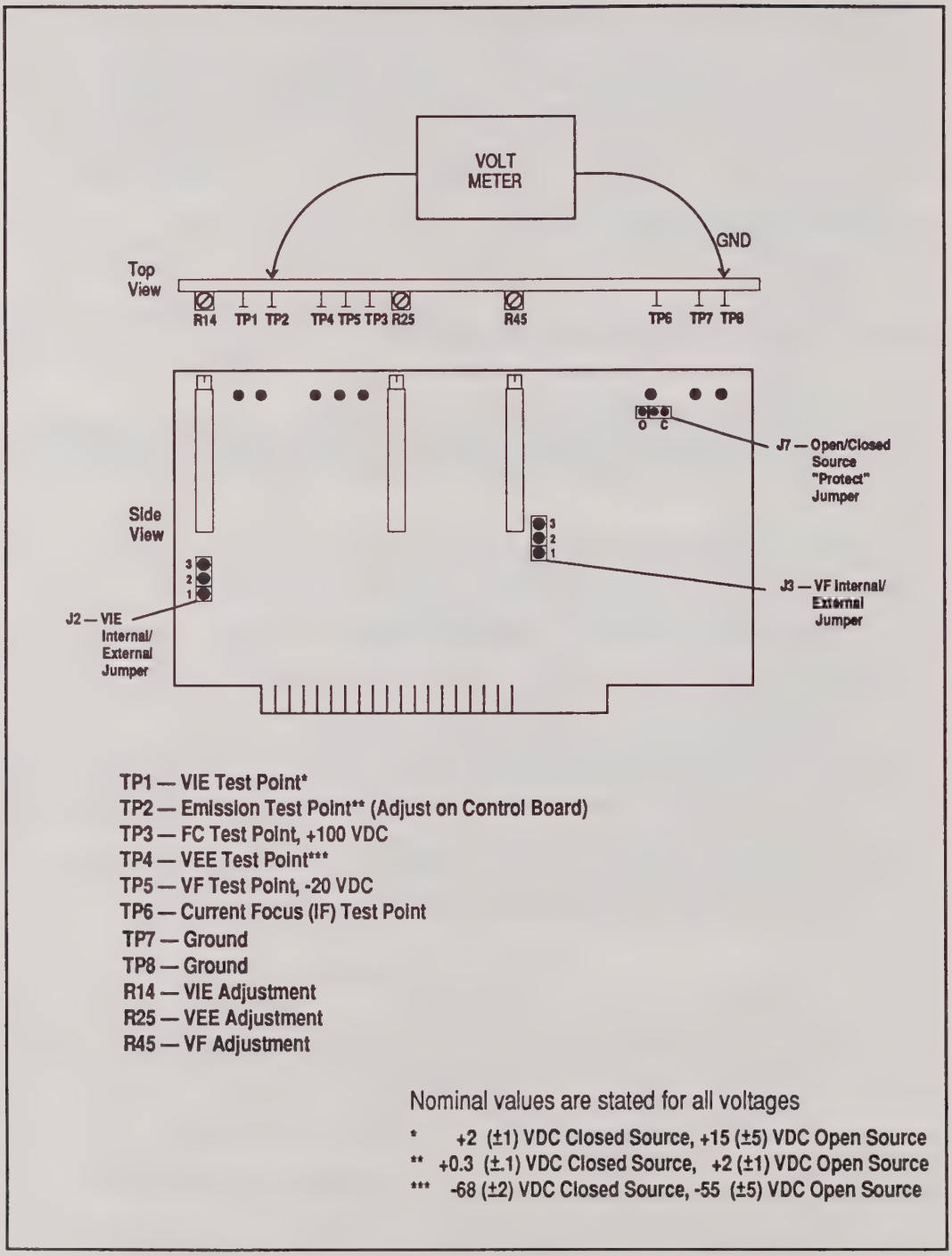
This jumper is used for selection of either a local potentiometer (R14) using pins 1 and 2 or a remote DAC input (not presently supported). The normal position is pins 1 and 2.

J3 - Voltage Focus (VF) Internal/External Jumper

This jumper is used for selection of either a local potentiometer (R45) using pins 2 and 3 or a remote DAC input (not presently supported). The normal position is pins 2 and 3.

J7 - Open/Closed Source "Protect" Jumper

This jumper changes the gain of the current-to-voltage converter U9. The jumper is set to "O" for an open ion source and "C" for a closed ion source.



TP1 — VIE Test Point*
TP2 — Emission Test Point** (Adjust on Control Board)
TP3 — FC Test Point, +100 VDC
TP4 — VEE Test Point***
TP5 — VF Test Point, -20 VDC
TP6 — Current Focus (IF) Test Point
TP7 — Ground
TP8 — Ground
R14 — VIE Adjustment
R25 — VEE Adjustment
R45 — VF Adjustment

Nominal values are stated for all voltages

* +2 (±1) VDC Closed Source, +15 (±5) VDC Open Source
** +0.3 (±.1) VDC Closed Source, +2 (±1) VDC Open Source
*** -68 (±2) VDC Closed Source, -55 (±5) VDC Open Source

Figure 6-2. Ionizer Board - Test Points and Adjustments

6.4 Control Card

References: Figure 6-3, Schematic 12-4A, and Assembly Drawings 12-4B and 12-4C.

The autoranging and fixed range is activated by selection of Jumpers J6, J7, J8, J9, J10, and J20 on the Control Card as follows:

	Jumper On/Off					
Mode	J6	J7	J8	J9	J10	J20
Autorange 10^{-6} and 10^{-8}	Off	Off	On	Off	On	On
Fixed Range 10^{-7}	Off	On	Off	On	Off	On

TP1 - Servo Emission Test Point

This Servo Test Point is measured during the adjustment of the Emission Set Point, **but should not be confused with the direct method of measuring emission at TP2 on the Ionizer Board.** The conversion factor between voltage read at this test point and the corresponding emission current is 1.0 VDC = 0.5 mA. Therefore, a reading of 0.6 VDC would correspond to an emission current of 0.3 mA. The emission setpoint is controlled by adjustment of R39 on the Ionizer Board.

J1 - Digital I/O Board Jack (I)

This Cable Jack is connected to the Digital I/O Board.

J2 - Digital I/O Board Jack (II)

This Cable Jack is connected to the Digital I/O Board.

J3 - Filament Power Jack

This Cable Jack is connected to the Filament Power.

J4 - Multiple Wire Jack

This Cable Jack is connected to multiple wires.

J5 - Remote Control Interface Jack

This Cable Jack is connected to the Remote Control Interface.

J6 - Auto Range Control Jumper (I)

Jumper J6 is Off for autorange operation (10^{-6} and 10^{-8}) and On for fixed range operation (10^{-7}).

J7 - Auto Range Control Jumper (II)

Jumper J7 is Off for autorange operation (10^{-6} and 10^{-8}) and On for fixed range operation (10^{-7}). For fixed range operation move J8 to J7.

J8 - Auto Range Control Jumper (III)

Jumper J8 is On for autorange operation (10^{-6} and 10^{-8}) and Off for fixed range operation (10^{-7}). For fixed range operation move J8 to J7.

J9 - Auto Range Control Jumper (IV)

Jumper J9 is Off for autorange operation (10^{-6} and 10^{-8}) and Off for fixed range operation (10^{-7}).

J10 - Fixed Range Jumper #1

Jumper J10 is On for autorange operation (10^{-6} and 10^{-8}) and Off for fixed range operation (10^{-7}).

J11 - EM POT

Jumper J11 must On to select R39 for adjustment of the Emission Current. Jumper J11 must be Off for external control of the Emission Current by a DAC (not used at this time).

J12 - EM DAC

Jumper J12 must Off to select R39 for adjustment of the Emission Current. Jumper J12 must be On for external control of the Emission Current by a DAC.

J13 - MUX Control Output Jumper (I)

Jumper J13 is Off when a Multiplexer is not installed and On when a Multiplexer is installed.

J14 - MUX Control Output Jumper (II)

Jumper J14 is Off when a Multiplexer is not installed and On when a Multiplexer is installed.

J15 - Fixed Range Jumper #2

Jumper J15 is used to enable and disable Auto-Ranging. When the J15 jumper is On, the Auto-Ranging circuit locks into the least sensitive range (10^{-6}).

J16 - MUX Control Output Jumper (III)

Jumper J16 is Off when a Multiplexer is not installed and On when a Multiplexer is installed.

J17 - Faraday Cup Jumper

Jumper J17 is installed to use the Faraday Cup Mode when servicing is required. This mode allows the Faraday Signal to be read directly without amplification by the electron multiplier. Use of this jumper connects the Faraday Cup and automatically removes the electron multiplier high voltage. In normal multiplier operation, the pins at Jumper J17 are not jumpered (connected to each other). This function can be software controlled.

J18 - Jumper

Jumper J18 is installed at the factory and should not be adjusted.

J19 - Jumper

Jumper J19 is installed at the factory and should not be adjusted.

J20 - Total Pressure Mode Jumper

Jumper J20 is On for Normal Operation. Jumper J20 is Off for Total Pressure Mode in which the total pressure displayed is independent of AMU.

J21 - RF Card Jumper (I)

Jumper J21 is Off to accommodate the most current I/F Card and On for the old Card.

J22 - RF Card Jumper (II)

Jumper J22 is On to accommodate the most current I/F Card and Off for the old Card.

SW1 - Protect Reset Disable/Enable

This switch allows the operator to toggle between Protect Enable and Disable to Reset (Clear) the protect circuitry logic without re-booting the system. The Protect Enable position is the Normal setting. To reset the protect circuitry, move switch SW1 to the Disable position then back to the Enable position.

R39 - Emission Potentiometer

This potentiometer sets the Emission Current. Monitor the corresponding signal voltage at TP1. See TP1 for the voltage to current conversion.

After installing the new ionizer filaments, but **before** turning the power on, perform the following adjustment:

1. Turn the Emission Potentiometer (R39) to zero (full **clockwise**).

2. Turn power On.

3. Turn R39 **counter-clockwise** very slowly (over a period of 5 minutes) until .3V is measured between TP2 and TP8 on the Ionizer Board, as shown in Figure 6-2.

DS1 - Total Pressure LED

This status lamp is normally Off. During the period that the lamp is On, the quadrupole and its electron multiplier act like an ion gauge, without mass selection. When the status lamp is On, the system is in the Total Pressure Mode.

DS2 - Multiplier/FC LED

This status lamp is normally On. An On status lamp indicates that the multiplier power supply is On.

DS3 - Single Filament LED

This status lamp is normally Off. An On status lamp indicates that only one of the two filaments is operational.

DS4 - Open Filament LED

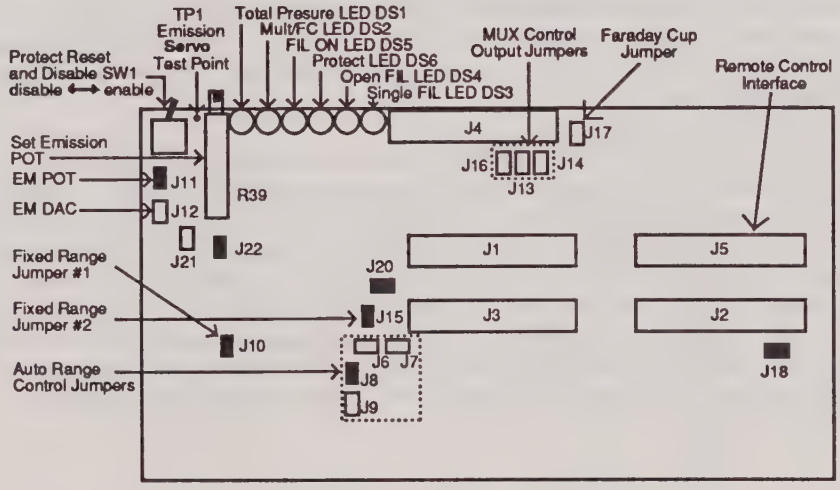
This status lamp is normally Off. An On status lamp indicates that the filament supply has no load. This condition is prompted by a voltage in excess of 8 VDC caused by a high resistance in the filament circuit or an open filament.

DS5 - Filament On LED

This status lamp is normally On when the filaments are On and Off when the filaments are Off.

DS6 - Protect LED

This status lamp is normally Off. An On status lamp indicates that a pressure in excess of 10^{-3} Torr has been detected at the filaments. To recover from a filament protect status, you must first confirm that pressure at the probe has been reduced to less than 10^{-3} Torr. To reset the protect circuitry, move switch SW1 to the Disable position then back to the Enable position.



Notes:

■ = Jumper Normally On
DS2: On = Multiplier On
DS5: On = Filament On/Not Open
DS6: On = Protect Tripped

Figure 6-3. Control Board - Test Points and Adjustments (Autorange Jumper Configuration Shown)

6.5 Power Supply - Filament Board

References: Figure 6-4, Schematic 12-5A, and Assembly Drawing 12-5B.

> **CAUTION**
>
> **These potentiometers are pre-set at the factory and should not be adjusted unless the circuit board is replaced or if thoriated/iridium filaments have caused a circuit imbalance.**

R12 - Filament Current Limit Adjustment

This potentiometer is used to limit the filament current to 6 A or less. This variable resistor is set at the factory and should not require adjustment. Contact the factory if you want to change this setting.

R21 - Single Filament Set Adjustment

This potentiometer is used to set the single filament detection threshold. Under normal two-filament operation, the single filament LED indicator in the console is Off. (This is the DS3 LED on the Control Board under the console cover. See Figure 6-3.) This potentiometer is set by adjusting it so that the DS3 LED turns Off when the system is known to have healthy filaments and is operating normally. A change in the current/voltage relationship of the filament will then cause the console to turn on the single filament LED. A message will flash on the VGA Monitor immediately following the filament ramp-up to indicate whether one or two filaments are in operation.

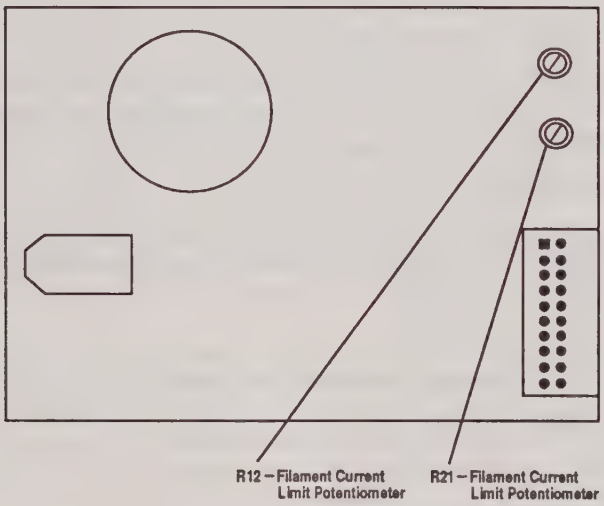


Figure 6-4. Filament Power Supply Board - Test Points and Adjustments

6.6 Rod Driver Board

References: Figure 6-5, Schematic 12-6A and Assembly Drawing 12-6B.

CAUTION

These potentiometers and capacitors are pre-set at the factory and should not be adjusted unless recommended by a factory representative. Replacement boards are pre-set at the factory and should not require adjustment. These adjustments are critical to the performance of the QualiTorr Remote and mis-adjustment may result in serious performance degradation.

TP1 - (-) Voltage Reference Test Point

This test point is used to measure the negative reference voltage. The voltage at this test point should be -10.000 ± 0.001 VDC. See R12 on the mother board for adjustment. Reference: Section 6.8.

TP2 - (+) Voltage Reference Test Point

This test point is used to measure the positive reference voltage. The voltage at this test point should be +10.000 ± 0.001 VDC. See R12 on the mother board for adjustment. Reference: Section 6.8.

TP3 - (–) Rod Output Test Point

This test point is used to measure the negative rod output.

TP4 - (+) Rod Output Test Point

This test point is used to measure the positive rod output.

TP5 - DC Clamp Output Test Point

This test point is used to measure the DC clamp output. See potentiometer R47B.

R13 - (-) Rod Amplifier Zero

This potentiometer controls the zero point of the negative rod amplifier To adjust R26, short the input pins of J1 and set the output voltage at J4 pin 1 to 0.000 ± 0.001 VDC. See potentiometer R47B.

R26 - (+) Rod Amplifier Zero

This potentiometer controls the zero point of the positive rod amplifier. To adjust R13, short the input pins at J1 and set the output voltage at J3 pin 1 to 0.000 ± 0.001 VDC. See potentiometer R47B.

R47A - (±) Rod Balance Adjustment

This potentiometer provides a gain adjustment to make the (-) Rod Amplifier gain equal to the gain of the (+) Rod Amplifier and ensure that they track with precision. To

adjust the Rod Balance, apply 10 VDC on J1 and set the output so that they are within ± 0.010 VDC of each other.

R47B - Rod DC Clamp

The rod DC amplifiers have a DC clamp added to the circuit. This clamp is used to reduce the "On Blast." The "On Blast" is a peak at mass zero that occurs because the mass filter is not "On" at zero AMU. Reducing the "On Blast" helps resolve AMU 1 and 2 from the "On Blast." The clamp stops the DC from dropping below a setpoint and is adjusted with potentiometer R47B. The clamp is adjusted by scanning at AMU 1 with a zero width scan and turning up the adjustment (R24 clockwise on 4052B version card and R47 counter-clockwise on the new 5575A version card) so that the signal at AMU 1 just starts to drop in amplitude. This sets the "brake-point" for the clamp at AMU = 1. Please note that the DC rod amplifier's zero adjustments R26 and R13 should be zeroed with the DC clamp turned down to zero (Off). See Figure 6-5 and 6-5A.

C2 - (+) Rod Compensation Adjustment

This capacitor provides frequency compensation for the (+) amplifier. To adjust C2, use a function generator with a square wave to insert an input signal. The adjustment is made by minimizing overshoot and ringing.

C18 - (-) Rod Compensation Adjustment

This capacitor provides frequency compensation for the (-) amplifier. To adjust C18, use a function generator with a square wave to insert an input signal. The adjustment is made by minimizing overshoot and ringing.

You can check for DC output by selecting one peak at zero width in the programmable scan. Voltage out should be about .5V per AMU. Output should be read at J3-Pin 1, and J4-Pin 1. Voltages are referenced to the grid on the ionizer board TP7 or TP8.

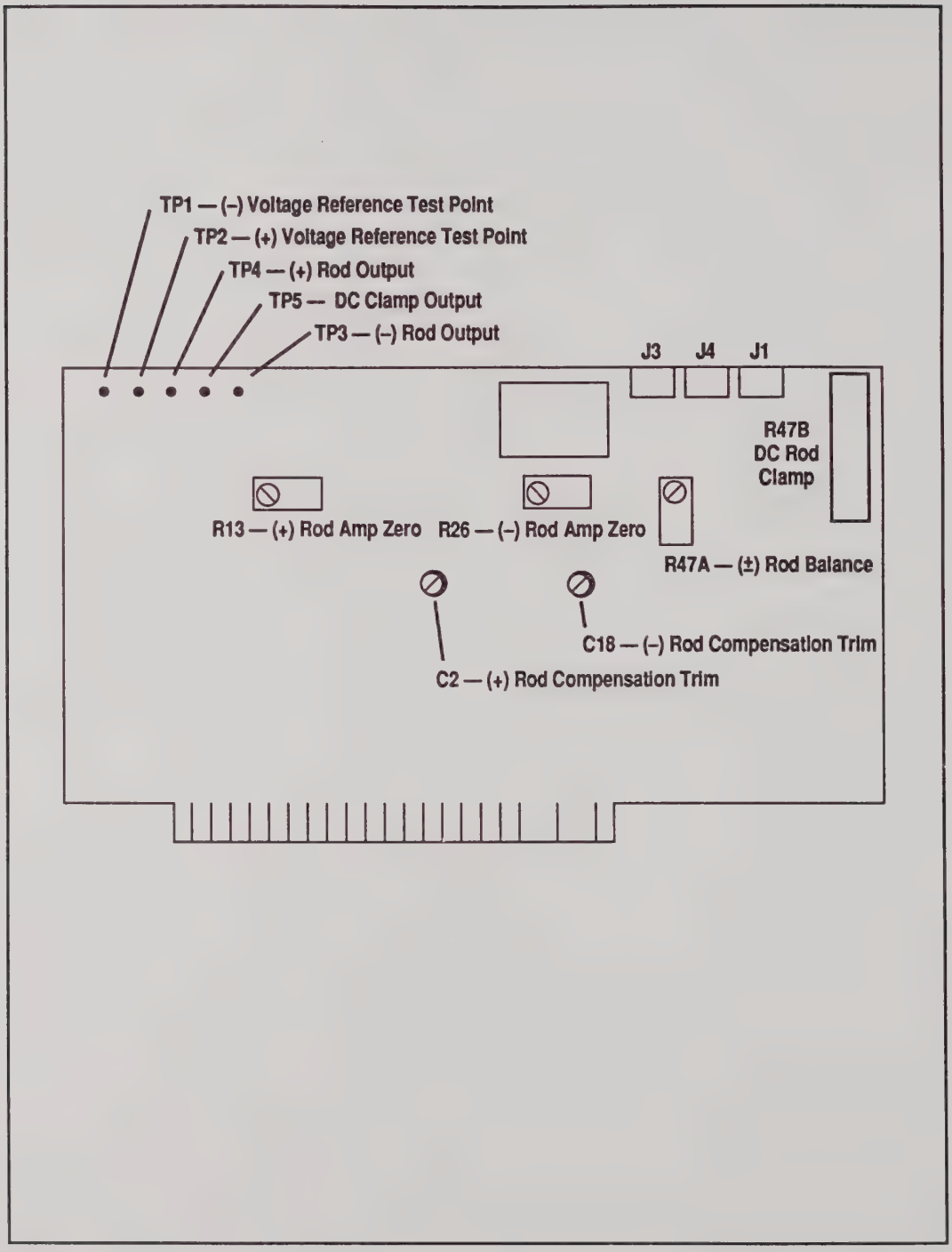

TP1 — (–) Voltage Reference Test Point
TP2 — (+) Voltage Reference Test Point
TP4 — (+) Rod Output
TP5 — DC Clamp Output
TP3 — (–) Rod Output
J3
J4
J1
R47B
DC Rod
Clamp
R13 — (+) Rod Amp Zero
R26 — (–) Rod Amp Zero
R47A — (±) Rod Balance
C18 — (–) Rod Compensation Trim
C2 — (+) Rod Compensation Trim

Figure 6-5. Rod Driver Board - Test Points and Adjustments

6.7 Signal Processor Board

References: Figure 6-6, Schematic 12-7A and Assembly Drawings 12-7B and 12-7C

TP1 - I/F Input Signal

The output of the electrometer at this test point is the same as TP8 or TP9, but buffered by U2 and inverted. The optional QualiTorr Scan Box can be connected to this point to observe analog spectra on an oscilloscope.

TP2 - V/F Temp Set

This test point is used to measure the command setting of the regulator that controls the temperature of U5. A setting of 50°C is indicated by a reading of 500 mV. Potentiometer R25 is used to make adjustments of the command signal.

TP3 - V/F Temp

This test point is used to measure the temperature of U5. A temperature of 50°C is indicated by a reading of 500 mV. If the temperature regulator is working properly, the difference between the temperature setting measured at TP1 and the temperature of U5 measured at TP2 should be less than 1°C.

TP4 - (+) 15 VDC

The positive voltage output of the local 15 VDC regulator is measured between this test point and ground.

TP5 - (-) 15 VDC

The negative voltage output of the local 15 VDC regulator is measured between this test point and ground.

TP6 - I/F Output Signal

This test point is used to measure the output pulses from the line driver U1 with an oscilloscope. The signal conversion is 1 Hz = 1 picoamp or 10 MHz = 10 microamps. The full-scale reading is 10 MHz. See the Auto-ranging Chart in Section 9.1.4 to obtain intermediate settings.

TP7 - DAC Zero

This test point is used by the factory.

TP8 - Multiplier Signal

The electron multiplier electrometer signal output is measured at this test point. Refer to the auto-ranging chart in Section 9.1.4 to obtain the current to voltage transfer function.

TP9 - FC Signal

The Faraday Cup electrometer output signal is measured at this test point. A measured signal of 1 VDC = 1 x 10^{-8} amps.

TP10 - Over Range (Auto Ranging)

The over-range signal used by the auto-ranging circuit is measured at this set point. This signal is used by the auto-ranging circuitry to determine whether it will switch to a new range. Refer to the discussion of the auto-ranging circuitry in Section 9.1.4.

TP11 - (+) 5 VDC

The positive voltage output of the local 5 VDC regulator is measured between this test point and ground.

R25 - V/F Temp Set

This potentiometer sets the temperature of a thermostated heater. The regulator circuit (Q2, U8, and U13) maintains a constant temperature to eliminate any temperature drift of the voltage-to-frequency converter U5. The voltage conversion is 10 millivolts for each degree Celsius (10 mV/°C). A voltage of 0.50 VDC corresponds to a regulated temperature of 50 °C. The temperature is maintained by heaters R20 and R19 under U5's socket.

R8 - Multiplier Zero

This adjustment is made to insure a proper electronic offset for noise subtraction by the computer. The adjustment is made in the analog mode of scanning (Programmable Scan mode). Do not make this adjustment unless the probe has been operating for at least 30 minutes and thermal equilibrium in the electronics has been established. Also, it is necessary to precede this adjustment with a gas calibration to establish a Maximum Operating Pressure (MOP). For normal (multiplier) operation, the J5 jumper is removed. Turn the filaments Off. Now adjust R8 so that the baseline is 5 $^1/_2$ decades down from the Maximum Operating Pressure of the most recently run calibration. Note, if the MOP entered is not exactly $1.0E^X$ Torr, the system makes MOP equal to $1.0E^{X+1}$ Torr. The adjusted level will always be about mid-range on the bottom decade.

R9 - FC Zero

The procedure for adjusting the FC Zero is the same as that for the multiplier (explained above) but there are a few important differences. Since the Faraday Cup is rarely used, this adjustment will seldom be required. Jumper J17 must be in place on the Control Board (see Section 6.4), and the J5 Jumper should be inserted on the Signal Processing Board (see Section 6.7). Before the jumpers are added, a normal gas calibration must be made using the multiplier to establish the Maximum Operating Pressure, as explained above. The filaments should be turned Off. Now R9 can be adjusted to the 5 $^1/_2$ decade position.

R32 - Clamp Adjustment

This potentiometer is set at the factory and should not be adjusted. If adjustment is required, this potentiometer is set while in the selected peak monitor mode. Apply 11 to 12 microamps to the multiplier input. Adjust the clamp adjustment (R32) until you read 10.5 VDC at TP1. This is a factory, not a field, adjustment. See Figure 6-6A.

J1 - I/O Jack

This output jack is the pulse output to the Digital I/O board in the console.

J2 - DAC Zero

This jumper is set to be Open at the factory and should not be changed.

J3 - POT Zero

This jumper is set to be Closed at the factory and should not be changed.

J4 - FC/Multiplier Enable

This jumper enables the Faraday Cup/Multiplier Control Line and is normally On. This jumper must be in place to control either the Faraday Cup or Multiplier from the control console. See Control Board Faraday Cup Jumper J17 in Section 6.4.

J5 - FC/Multiplier Jumper

This jumper allows the selection of the Faraday Cup relay for testing the Faraday Cup electrometer. If the jumper is Off, the Multiplier Mode is activated. If the jumper is On, the Faraday Cup Mode is activated, but the electron-multiplier high voltage may still be On. Use of Jumper J17 on the Control Board (Figure 6-3) is the preferred way to use the Faraday Cup for data-taking. (See Sections 6.4 and 9.3.4.2.) The normal setting for the QualiTorr is with the J5 jumper Off.

DS1 - Range Lamp

The range is 10^{-6} when On and 10^{-8} when Off.

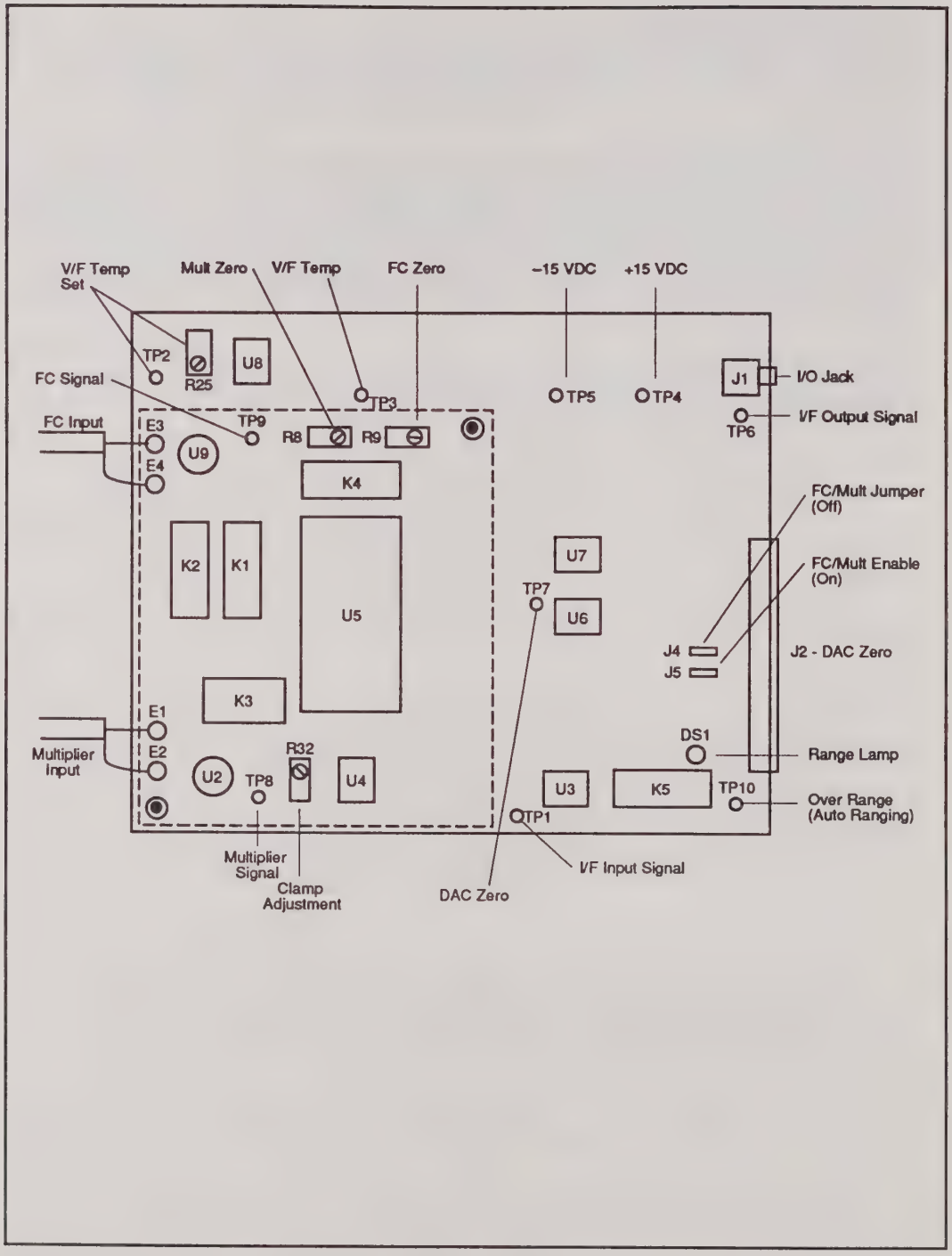


Figure 6-6. Signal Processor Board - Test Points and Adjustments

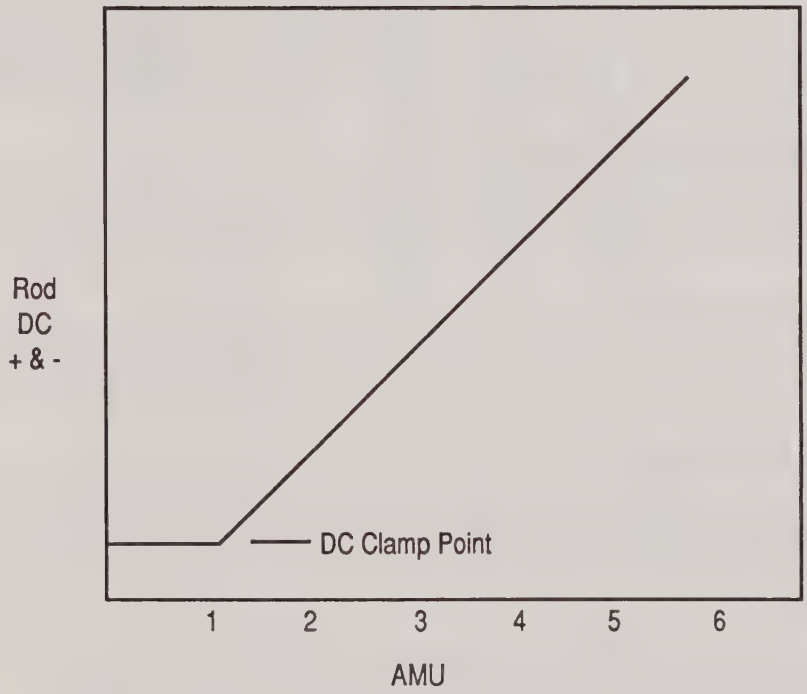


Figure 6-6A. Clamp Adjustment

6.8 Mother Board

References: Figure 6-7, Schematics 12-8A and 12-8B, and Assembly Drawings 12-8C and 12-8D

R4 - Rod Voltage Adjustment

This trim potentiometer controls the output voltage of the ± 250 VDC supply. To adjust R4, measure between the (+) side of C17 and ground and set to 250 VDC.

R20 - Reference Voltage Adjustment

This trim potentiometer controls the highly regulated reference voltage power supply. The voltage may be measured at U3 pin 6 of the output amplifier or at TP1 and TP2 of the Rod Board (see Section 6.6). To adjust R12, measure the reference voltage and set to 10.000 ± 0.001 VDC.

R13 - 28V Power Supply Adjustment

This potentiometer controls the voltage power supply for RF. The voltage may be measured at pin 4 of connector J6. To adjust, measure the voltage and set to 28.000 +/- 2% VDC.

F1, F2, and F3 Picofuses

These fuses should test Not Open with a continuity meter. If a fuse has blown, it can be replaced by carefully unsoldering from the top of the QualiTorr Remote without removing the board. Replace with 10 A Picofuses.

F4, F5, and F6 Picofuses

These fuses should test Not Open with a continuity meter. If a fuse has blown, it can be replaced by carefully unsoldering from the top of the QualiTorr Remote without removing the board. Replace with 1 A Picofuses.

F7 Picofuse

This fuse should test Not Open with a continuity meter. If a fuse has blown, it can be replaced by carefully unsoldering from the top of the QualiTorr Remote without removing the board. Replace with a 15 A Picofuse.

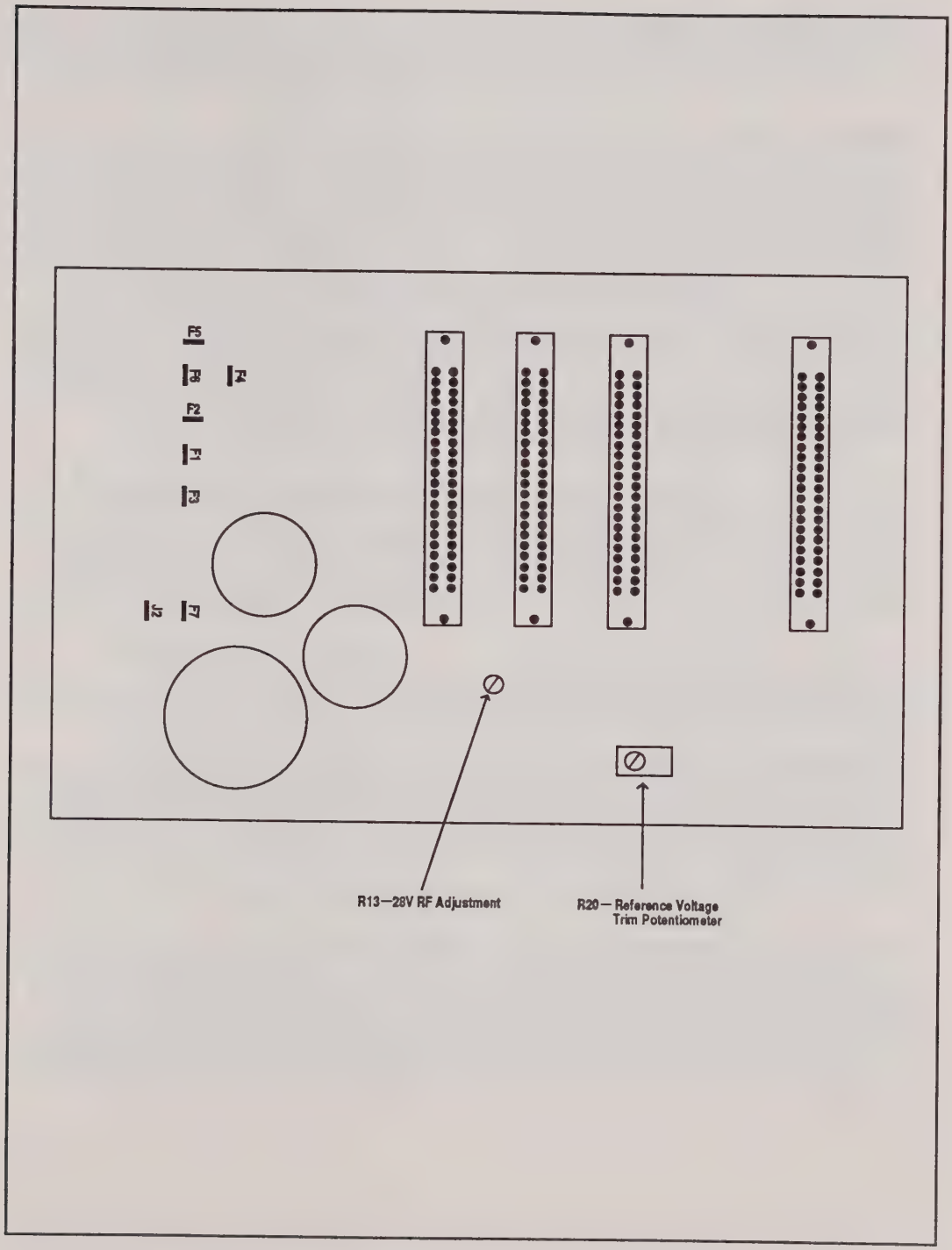


Figure 6-7. Mother Board - Test Points and Adjustments

6.9 RF Power Board

References: Figure 6-8, 6-9, and 6-10, Schematic 12-9A, and Assembly Drawing 12-9B

S1 - Tune Switch

The tune switch on the RF Power Board disables the RF Servo and sets the RF output at 95% power. (See Figure 6-8). This allows testing and "**Coarse Tuning**" of the RF Power Board and RF Tank. To *Coarse Tune* the RF Tank, you set the Tune Switch to *Tune* and adjust the Tuning Capacitor for maximum signal at the RF Test Point. The RF Test Point is in the center of the RF Control Board (See Figure 6-11). To test the RF Power Board, set the Tune Switch to *Tune* and measure the RF on an oscilloscope connected to the RF Test Point. If it reads approximately 20 ± 2 VAC Peak, then the RF Power Board is OK. **Fine Tuning** of the Tank is done using the UTI "Scan Box." Figure 6-9 shows a set of waveforms. The waveforms are displayed on an oscilloscope while sweeping the RF with a linear ramp from zero to maximum output using the UTI Scan Box. Waveforms shown in Figures 6-9 with 20 ± 2 VAC apply in this case as well.

The top wave form in Figure 6-9 shows the tank tuned slightly on the capacitive side of resonance. The foldback of the RF envelope is due to excessive power being drawn by the tank. The foldback is not always very pronounced. The excessive power draw will overheat the RF Box and degrade the performance of the QualiTorr Remote. A quick check of the RF tuning can be made by simply feeling the cooling fins on the RF Box. A good rule-of-thumb is that if the fins are hot, the RF Tank is out of tune.

The bottom wave form in Figure 6-9 shows the tank tuned to peak amplitude (resonance). The distortion at the top and bottom of the envelope is due to overloading the RF Detector. The RF envelope should look like this after Coarse Tuning.

The wave form in the center of Figure 6-9 shows the RF envelope after "Fine Tuning" of the tank. The correctly adjusted tank is tuned to the inductive side of resonance. This tuning improves the efficiency of the coupling between the Tank and the RF Power Board and allows the RF Box to run cooler. However, if it is tuned too far off the peak, the RF will not reach the higher AMU values. The peak value of the envelope should not be less than 20 VAC (40 ± 4 VAC for the complete peak-to-peak envelope).

Figure 6-10 shows two test configurations used with the Scan Box. The configurations for coarse and fine tuning of the RF tank are shown. In addition, the configuration for displaying an analog spectrum using Scan Width and Scan Center controls is shown. The analog spectrum is obtained by connecting the vertical input of the scope to TP1 on the Signal Processor Board and connecting the scope horizontal input to the Scan BNC connector on the UTI Scan Box. When tuning is complete, switchback the Tune Switch to *Normal*.

Suggested RF Fine Tuning Procedure with Scan Box

This procedure is required whenever a QualiTorr Probe or RF Generator are replaced. This is because the Probe and the RF Generator are matched at the factory. This procedure requires the Optional UTI Scan Box and should be conducted with the instrument operating in Programmable Scan (Local Mode) or Analog Scan (Host Computer Mode).

1. Use scope at 1 V/cm (10:1 scope probe). **Tune Switch at Normal.**
2. Attach vertical scope input to RF loop (next to the heat sink) on the RF Control Board. See Figure 6-11.
3. The Scan Box "RF Gen" BNC cable goes to the cable that was connected to Pin 9 (rear pin) of the Analog/Digital I/O Board in the Station Controller.
4. Scan Box "Sweep" cable goes to the scope's horizontal (x) input.
5. Scan Center of the Scan Box should be full counter-clockwise (CCW).
6. Scan Width full clock-wise (CW).
7. Scan Rate full clock-wise (CW).
8. Adjust airgap capacitor (*Tune* Capacitor) for power draw on to the output stage of the Power Board, Figure 6-8, to get maximum output (typically 20 ±2 VAC peak or 40 ± 4 VAC peak-to-peak) on the scope's display. Measure across R4 on the Power Board for 0.6 ±.05 VDC. Then, readjust the tuning capacitor 5% off of the peak to the inductive side of resonance. The voltage across R4 will drop. See Figure 6.8A.

Suggested RF Fine Tuning Procedure with a Digital Volt Meter and Oscilloscope (without Scan Box).

This procedure is required if the QualiTorr Probe or RF Generator are changed. This procedure does not require the Optional UTI Scan Box, but does require a digital volt meter.

1. Warm up the electronics for at least 30 minutes. An optimum warmup is 3 hours. This allows the probe, with filaments On, to come to thermal equilibrium. Scan around AMU 28 with a 56 AMU width with filaments On.

2. Switch S1 on RF Power Board to "Tune Mode." Adjust tuning capacitor for a clean sine wave using a scope on the RF test point on the RF Control Board. This prevents tuning a harmonic.

3. Readjust the tuning capacitor for peak output. This sets the coarse tuning.

4. Switch S1 back to "Normal Mode."

5. Remove scope probe from RF test point.

6. Load and run the QualiTorr III software to scan in programmable (analog) mode at 199 AMU with zero width.

7. Measure the Rod DC voltage at TP4 on the Rod Board (J3 Pin 1 on older board version). Record the value.

8. Measure the Rod DC voltage drop across R4 (R8 on older board version) and readjust the tank's tuning capacitor by turning it clockwise slightly for the minimum voltage drop across R4. This is fine tuning, so only a small adjustment should be required. See Figure 6-8A.

9. Measure the Rod DC voltage at TP4 on the Rod Board (J3 Pin 1 on older boards). If the voltage has dropped from the recorded value in Step 7, then reverse the tuning back toward the peak setting until the Rod DC matches the recorded value. This last step should only be needed for "cabled RF" systems.

This procedure sets the tank at the most efficient operating point and is not dependent on the Q of the tank. If the drop across R4 will not go below 0.75 VDC, then it is likely the Q of the tank is too low and the toroid may need to be replaced.

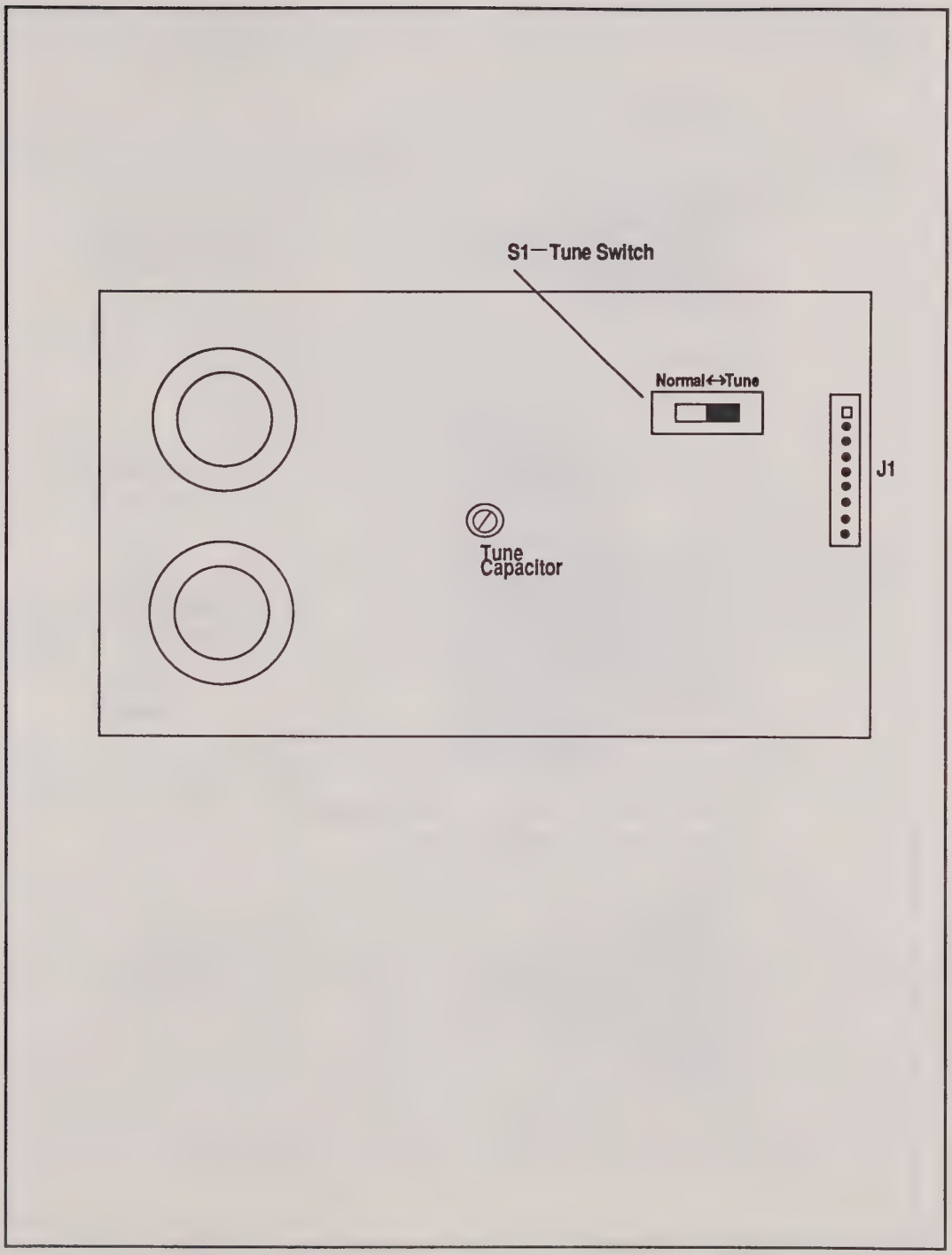


Figure 6-8. RF Power Board - Tune Switch and Tune Capacitor

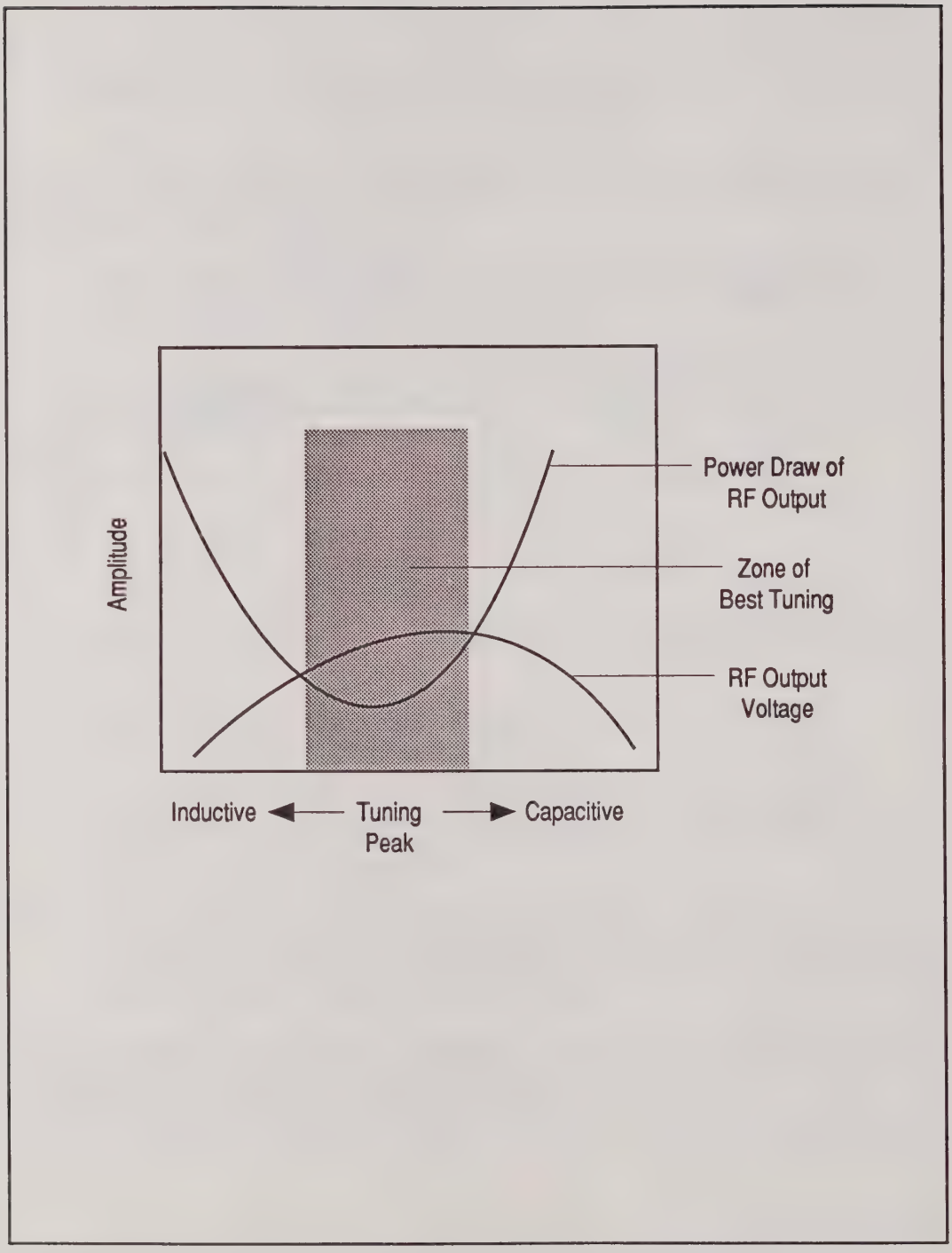


Figure 6-8A. Tune Capacitor RF Power and Voltage

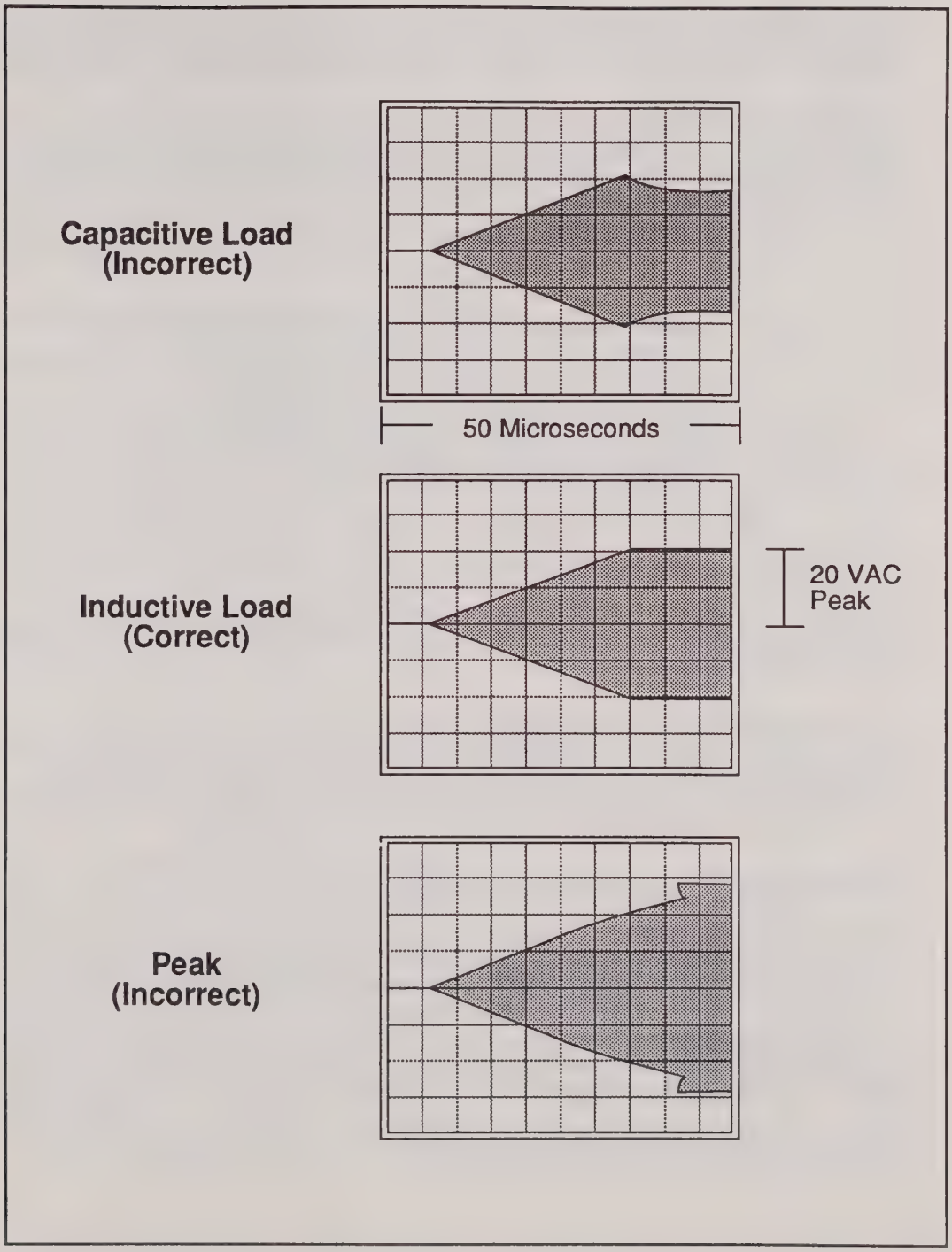


Figure 6-9. RF Power Adjustment: Insufficient Current (Top), Correct Adjustment (Center), and Excessive Current (Bottom).

6.10 RF Control (Local Mode)

References: Figures 6-10 to 6-16, Schematic 12-10A, and Assembly Drawing 12-10B

Some of the adjustments that are required on the RF Control Board are greatly facilitated by the use of a UTI Scan Box and the UTI Calibration (Cal) Gas. The test and adjustment apparatus configuration that should be used when the Scan Box is used is shown in Figure 6-11.

> **CAUTION**
>
> **The RF Control Board has been pre-set at the factory and should not be adjusted unless you have received appropriate training. Capacitors C4 and C5 should only be adjusted by qualified personnel or authorized service representatives. It is highly recommended that the UTI calibration gas be used to provide known mass spectra during these adjustments.**

TP1 - Output of RF Detector Test Point

This test point is used to measure the output of the RF detector. When S1 on the RF Power Board is set to Tune, approximately 7 VDC should be read at TP1. S1 should be returned to Normal when testing is completed.

TP2 - Read Detector Temperature Test Point

This test point is used to measure detector temperature. The voltage conversion is 10 millivolts per degree Celsius (10 mV/°C). The voltage at TP2 should normally read 0.50 VDC to correspond to temperature regulation at the read detector of 50 °C.

TP3 - Set Detector Temperature Test Point

This test point is used to measure the voltage set point of the temperature regulator for the RF diodes. The voltage to temperature conversion is 10 mV/°C. TP3 should normally read 0.50 VDC to correspond to a temperature reading of 50 °C. See R52 for adjustment.

RF - RF Test Point

References: Section 6.9 and Figures 6-9, 6-10, and 6-11

This test point provides a feedback point for the RF Tank. A reading of 20 Peak VAC indicates that the RF Board is working properly.

R1 - Detector Compensation (+) Test Point

Reference: Figures 6-11 and 6-12

This test point is used to set the (+) detector compensation. An oscilloscope should be attached to this test point and chassis ground when adjusting C4 to ensure that a clean rectification trace is obtained. Figure 6-12 shows the following three examples of oscilloscope traces: The top trace shows a case of under-compensation, the center trace shows the correct clean rectification, and the bottom trace shows a case of over-compensation. See C4.

R4 - Detector Compensation (-) Test Point

Reference: Figures 6-11 and 6-12

This test point is used to set the (-) detector compensation. An oscilloscope should be attached to this test point and chassis ground when adjusting C5 to ensure that a clean rectification trace is obtained. Figure 6-12 shows the following three examples of oscilloscope traces: The top trace shows a case of under-compensation, the center trace shows the correct clean rectification, and the bottom trace shows a case of over-compensation. Note that Figure 6-12 shows the oscilloscope trace for the R1 (+) test point. The trace for measurement at R4 (-) will be inverted. See C5.

R25 - High Mass Location Adjustment

Reference: Figures 6-11 and 6-13

This potentiometer provides a gain trim for the location of high (> 100 AMU) mass peaks. Conduct a Programmable Scan (Local Mode) on a peak of known identity, such as xenon at atomic mass 129, 131, or 132. Adjust the potentiometer to center the peak at the correct AMU location on the display CRT.

R41 - Low Mass Location Adjustment

Reference: Figures 6-11 and 6-13

This potentiometer provides an offset adjustment for the location of low mass peaks. Conduct a Programmable Scan (Local Mode)on a peak of known identity, such as hydrogen at atomic mass of 2. Adjust the potentiometer to center the peak at the correct AMU location on the display CRT. (Note: Figure 6-12, while showing high mass peak locations, nevertheless demonstrates typical mass peak positions for all peaks related to mass markers). **It is highly preferable to adjust the Low Mass Location before the High Mass Location.**

R43 - Low Mass Resolution Adjustment

References: Figures 6-11, 6-14, 6-15 and 6-16

This potentiometer controls the resolution of low mass peaks. A known peak, such as hydrogen, 2 AMU, should have neighboring valleys at 1 AMU and of one decade (1/10) below the signal level of the reference peak. Deeper or flat valleys at the baseline between adjacent peaks indicate over-resolution and loss of sensitivity. Shallower valleys indicate insufficient resolution. (Note: While the referenced figures show resolution for high mass peaks, the resolution for low mass peaks would appear similar). Proper resolution adjustment is confirmed by viewing the logarithmic display of two adjacent peaks of *approximately* equal height. The valley between the two peaks should be approximately one decade (0.75 inch on the display) below the peak tops. After making this adjustment, resolution should be checked for the high AMU range and then re-checked for the low AMU range by performing the High Mass Resolution Adjustment.

R46 - High Mass Resolution Adjustment

References: Figures 6-11, 6-14, 6-15, and 6-16

This potentiometer controls the resolution of the high mass peaks. A known peak, such as xenon 132 should have a neighboring valley between the peak at 131 AMU of one decade (1/10) below the signal level of the peaks at 132 or 131 AMU. Deeper or flat valleys at the baseline between adjacent peaks indicate over-resolution and loss of sensitivity. Shallower valleys indicate insufficient resolution. After making this adjustment, the resolution should be re-checked at the low AMU range by performing the Low Mass Resolution Adjustment. Perform this adjustment by selecting a mass area in which adjacent peaks are approximately the same height.

R52 - Detector Temperature Adjustment

This potentiometer sets the detector temperature. The voltage measured at TP3 obeys the transfer function of 10 mV/°C. The standard operating setting is 0.50 VDC, corresponding to 50°C. See TP3 for the measurement test point.

C4 and C5 - Detector Compensation (-) and (+) Trim Adjustment

This adjustment requires an oscilloscope and a UTI scan box. The scan box generates a signal at the input of J3. The oscilloscope monitors the anode of CR1 and cathode of CR2 at Test Points R1 and R4, respectively. Adjustment is made at 100 AMU (approximate middle of Scan Center Control) to minimize ringing and parasitic oscillations and to achieve a clean half-wave rectification of the RF signal. The Scan Width should be full CCW (zero). The oscilloscope is connected to the R1 test point to adjust C4 and to the R4 test point to adjust C5. See R1 and R4 for the respective test points and Figure 6-12 for the wave forms.

This adjustment is rarely required after the instrument has left the factory. A symptom suggesting the need for this adjustment is the loss of peaks at either the high or low end of the spectrum. A procedure detailing this adjustment is provided on the next page.

The following adjustment is rarely necessary. If required, a scope and UTI Scan Box must be used. The instrument should be operating in Programmable Scan (Local Mode) or Analog Scan (Host Computer Mode):

Detector Compensation Adjustment Procedure

(The QualiTorr system should be operating in Programmable Scan)

Note: The Scan Box will allow faster scanning of the RF and faster adjustment of resolution, mass location, and timing, than can be done with the software.

1. Refer to the wave forms shown in Figure 6-12. Perform programmable scan at 100 AMU with zero width.

2. Using a vertical scope sensitivity of 50 mV/cm and a 10:1 scope probe, attach the scope probe, through a 3 pf capacitor, to the bottom of R1 on the RF Control Board (Figure 6-11).

3. The Scan Box "RF Gen" BNC cable is connected to the cable that was connected to Pins 3 and 4 of J9 on the Analog I/O Board. The "Sweep" cable goes to the scope's horizontal input. Scan Center should be in the approximate middle of its range and Scan Width should be full counter-clockwise (zero).

4. Adjust the scope's sweep to capture the wave forms.

5. Adjust C4 (near the heat sink) while looking at R1 to achieve the desired wave form shown in Figure 6-12. This corrects the positive compensation.

6. Now attach the scope's probe to the bottom of R4 and adjust C5 in the same manner to correct the negative compensation.

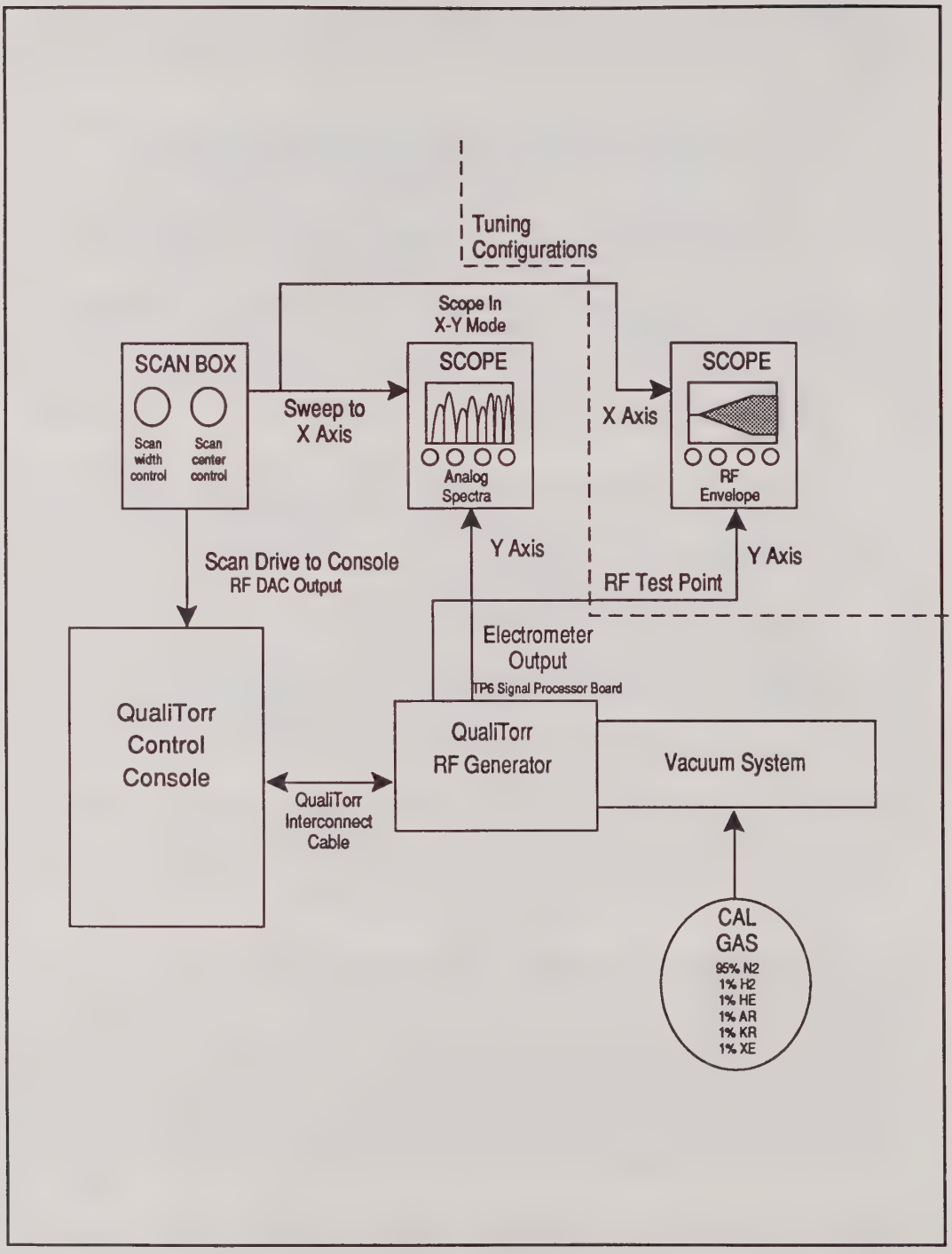


Figure 6-10. The Scan Box Testing and Adjustment Apparatus Configuration for Generating Analog Spectra

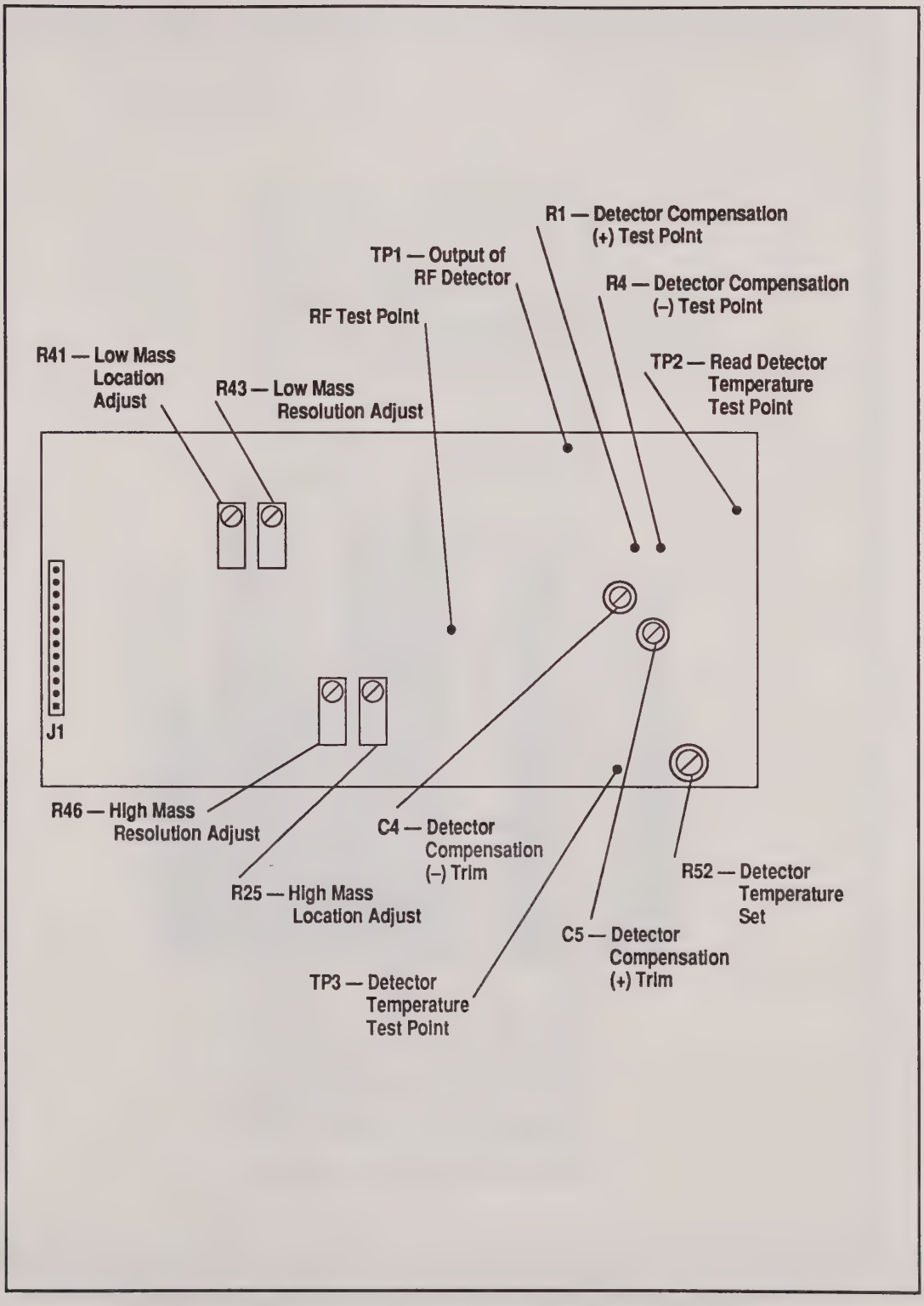

R1 — Detector Compensation (+) Test Point
TP1 — Output of RF Detector
R4 — Detector Compensation (–) Test Point
RF Test Point
R41 — Low Mass Location Adjust
R43 — Low Mass Resolution Adjust
TP2 — Read Detector Temperature Test Point
J1
R46 — High Mass Resolution Adjust
C4 — Detector Compensation (–) Trim
R25 — High Mass Location Adjust
R52 — Detector Temperature Set
C5 — Detector Compensation (+) Trim
TP3 — Detector Temperature Test Point

Figure 6-11. RF Control Board - Test Points and Adjustments

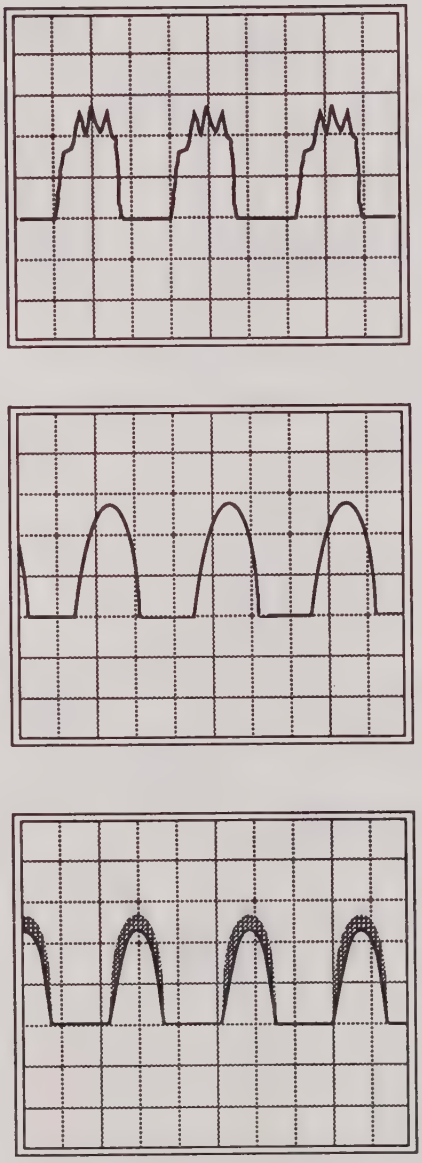


Figure 6-12. RF Rectification: Under-compensated (Top), Correctly Adjusted (Center), and Overcompensated (Bottom).

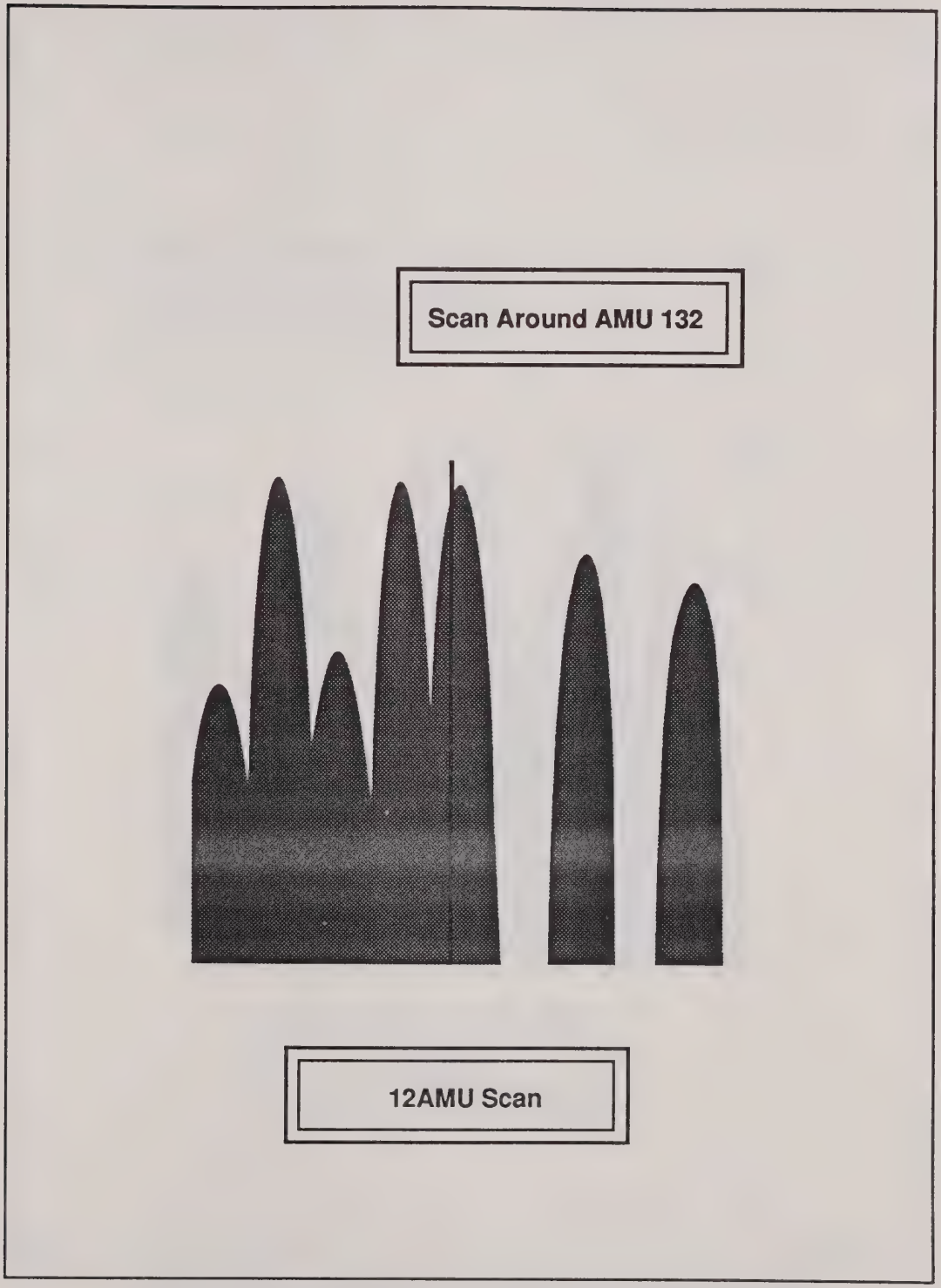


Figure 6-13. Mass Location Spectrum Showing A 0.25 AMU Error

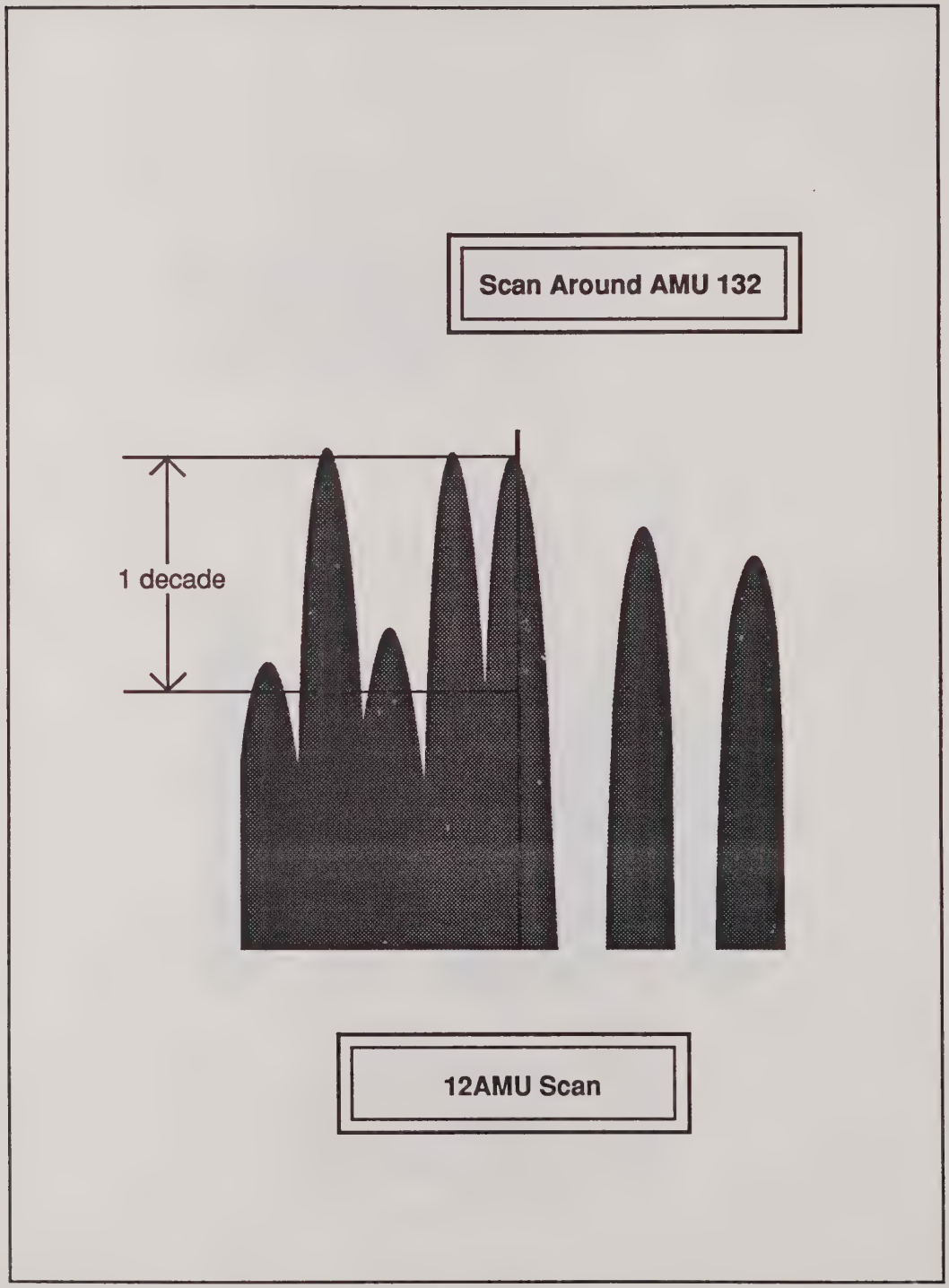


Figure 6-14. Mass Spectrum of a Properly-Resolved Xenon Group

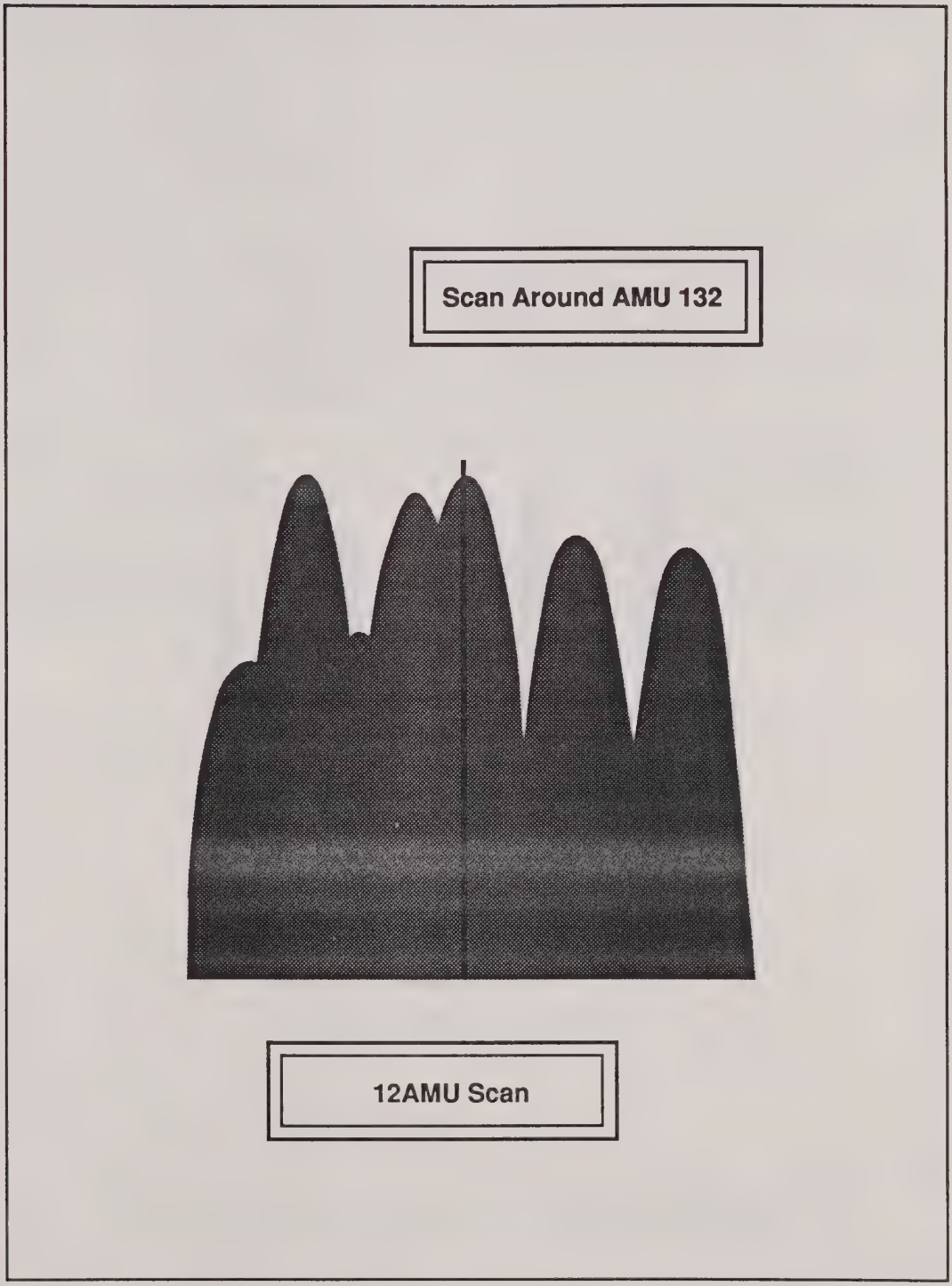


Figure 6-15. Mass Spectrum of an Under-Resolved Xenon Group

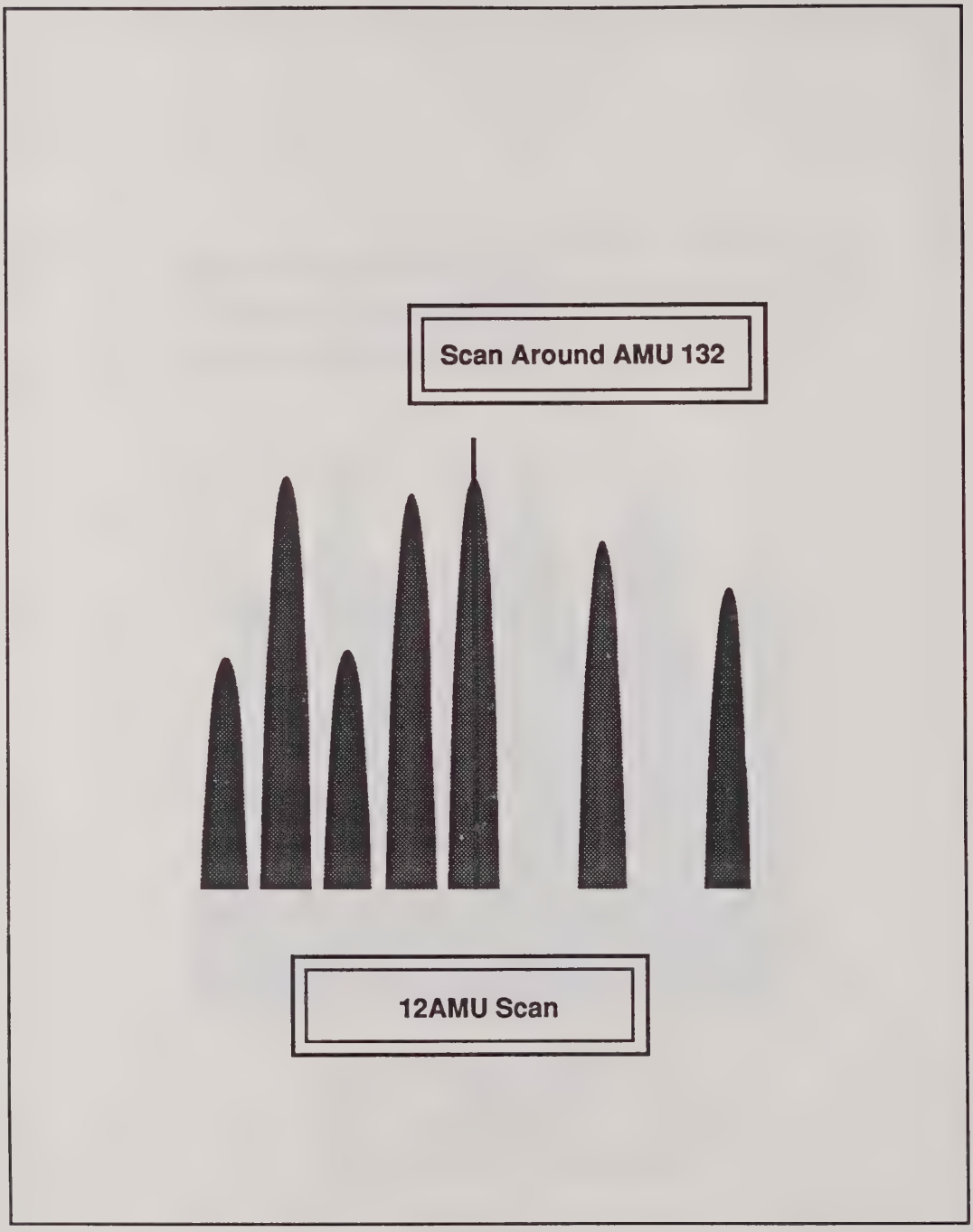


Figure 6-16. Mass Spectrum of an Over-Resolved Xenon Group

6.11 Analog/Digital I/O Board

References: Schematics 12-33A and 12-33B, and Assembly Drawing 12-34

TP23 - Ground 1

This test point is used as a ground reference when making measurements of signals on the digital side of the Isolation Amplifier.

TP24 - Ground 2

This test point is used as an alternate ground reference when making measurements of signals at TP26, TP28, 33, and on the analog side of the Isolation Amplifier.

TP26

This test point is used when setting the Zero (Offset) and Span (Gain) of the Electron Multiplier DAC using R63 and R64.

TP28

This test point is used when setting the Zero (Offset) and Span (Gain) of the Leak Hunt DAC using R67 and R68.

TP33

This test point is used when setting the Zero (Offset) and Span (Gain) of the RF Scan DAC using R79 and R80.

R80- RF Scan DAC Zero

This potentiometer is used to set the zero (offset) of the RF Scan Digital-to-Analog Converter (DAC). The potentiometer is set while the DC voltage is read between TP33 and TP 24. Set R80 so that a reading of 25 mVDC is obtained. This corresponds to one (1) AMU. Set programmable scan to 1 AMU with 0 AMU width.

J1

The connections on this jack go to the Computer Power Supply.

J2

This jack is connected to the (Optional) Analog Input.

J3

This jack is connected to the Digital I/O Card.

J5

This jack is connected to the Analog Power Supply.

J6

This jack is connected to the Analog Output at the Rear Panel

J7

This jack is connected to the Analog electronics.

6.12 Local Mode Calibration Adjustments

Reference: QualiTorr Short Manual Instructions, Appendix D.

To conduct Local Mode Calibration Adjustments, configure the QualiTorr Remote Station for Local Mode Operation. See Section 8.1.1.

The QualiTorr Remote is a Process Monitor, not an analytical instrument, although it performs many analyses on the data it acquires in order to present decisive information to the user. As a Process Monitor, it is similar to using a hand-held magnifying glass–or a "portable window"–to look in on various processes. The maximum dimensions of this window are fixed; it is 200 AMU wide and six decades high. This means that one mode of operating the QualiTorr Remote allows the user to see what gas constituents are present in a process station within the range of substances that have the following characteristics:

1. Atomic or molecular weights ranging from 1 to 200 AMU.

2. Partial pressures ranging over as much as eight decades of concentration or partial pressure.

The portability of this window means that the eight decades of pressure monitoring may be moved anywhere from atmospheric (760 Torr) and down eight decades, or into the ultra-high vacuum range of 10^{-7} Torr and down, or to any eight decades of pressures between UHV and atmospheric. This portability is achieved via the combined use of UTI's two-stage sampling procedure and by the CALIBRATION process.

The basic philosophy underlying the QualiTorr Remote calibration is that it is designed to be calibrated to the customer's process station; i. e., the gauging of the process station is the standard for setting the total pressure sensitivity coefficient for the QualiTorr Remote. This is the procedure for locating the window accurately so the process can be monitored with maximum visibility and knowledge.

The following procedure describes the recommended calibration procedure using the UTI Calibration (Cal) Gas and/or other single gases as the calibration standard.

The UTI Cal-Gas consists of 95% nitrogen and 1% each of hydrogen, helium, argon, krypton, and xenon. The exact proportions may vary slightly, as noted on the certification sheet that should be kept with the cylinder of Cal-Gas.

Sensitivity adjustments should be conducted in Host Computer Mode.

There are two major functions accomplished with "screw-driver adjustments" during calibration in Local Mode.

1. Location of mass peaks throughout the 1 to 200 AMU mass range

2. Resolution of mass peaks (clear separation of one mass peak from another)

6.12.1 Local Mode Mass Peak Location

Reference: QualiTorr Short Manual Instructions, Appendix D.

The location of a mass peak is defined as the point along the AMU axis where the maximum signal occurs for a given peak–the peak top. Ideally, these peak tops would occur at the center of the peaks which themselves would be changing slightly across the tops–i. e., nearly flat. For various reasons, these ideal peak shapes do not occur consistently from unit-to-unit, nor repeatedly in time. Therefore, for this reason alone, periodic calibration is desirable and recommended. The point along the AMU axis at which the peak top occurs is measured and converted to a digital value for computer correction and monitoring.

In the initial factory calibration, the actual location of six mass peaks is noted. The nominal location of each peak is stored on the System Disk, initially. When Programmable Scan is run across the various groups of peaks in the gas mixture, an orange marker shows the nominal location of the peak in the center of the screen. This is where the peak should be located–before any calibration is performed. See Figure 6-14 for an example of a mass location spectrum showing a 0.25 AMU peak location error.

The six peaks used for calibration–with integral values vs. actual decimal fraction values and calculated DAC drive values are listed in Table 6-1.

Table 6-1. Mass Calibration Data

Integral AMU	Gas	Actual Isotopic Mass	Nominal DAC Drive Values (163.84 x AMU)
2	Hydrogen	2.014	328
4	Helium	4.003	655
28	Nitrogen	28.006	4587
40	Argon	39.962	6554
86	Krypton	85.911	14090
136	Xenon	135.907	22282

If out of calibration, adjustments may be made to the analog electronics to bring the actual location as close as possible to the nominal location of each of the six calibration peaks. It is recommended that if the adjustment is made, the location of a low mass peak, e. g. 4 AMU, be done first. Then go to a high mass peak, like 132 AMU. It is not recommended that you start in the middle of the mass range. These adjustments are made via two pots in the RF generator box, so that the RF generator and the Probe become a matched set that should not be separated. This allows different Control Consoles to be used with different RF generator/Probe sets with essentially no extra adjustments necessary. If there is no deliberate or accidental change of the mass location analog electronics, then there is no requirement for adjusting these electronics later in the field during the operational lifetime of the QualiTorr Remote.

If no mass peak location adjustment is required, proceed to Section 4.5.3.2 to continue the calibration procedure. If mass peak adjustment is required, adjust the peak location at the RF Control Board. Reference: Section 6.10.

6.12.2 Local Mode Resolution of Mass Peaks

Reference: QualiTorr Short Manual Instructions, Appendix D.

The ability to resolve one mass peak from another is generally (and loosely) called the resolution, and has several definitions. UTI uses the term resolving power to be defined in the following way: The ratio of the atomic mass number (M) to the width of the mass peak at half maximum is equal to or greater than two times the mass number. Since this is a very laborious measurement to make, most mass spectroscopy users rely on the fact that this resolution occurs when the valley between two peaks of the same height is about 10% of the peak heights. This is the measurement used by UTI to set the resolution throughout the mass range. Note that this method of setting the resolution is not intended to produce Abundance Sensitivities of 10^4 or 10^5.

The resolution adjustment is entirely a manual process. The procedure for setting the resolution is to use the Programmable Scan to observe the spectra of the various gases in the UTI Cal-Gas mixture, starting with the low mass end, at 1, 2, and 4 AMU. The Low Mass Resolution pot in the RF Generator is adjusted at the factory by noting that there is a good separation between AMU 1 and 2. At the same time, AMU 4 is observed to ensure that it is neither over or under-resolved. A further observation is made while scanning the peaks from 1 to 30 AMU to note the relative resolution of peaks over the 14 to 18 and 28 to 30 AMU ranges.

After checking the low mass resolution, use programmable scan to check the xenon group of peaks from 128 to 136 AMU and note their relative resolution. The high mass resolution has been set at the factory by adjusting the RF generator until there is a 10% valley between 131 and 132 AMU. Note that 10% is one decade. See Figures 6-15, 6-16, and 6-17 for examples of properly, under-, and over-resolved peaks, respectively.

If no mass peak resolution adjustment is required, proceed to Section 4.5.3.3 to continue the calibration procedure. If mass peak resolution adjustment is required, adjust the peak resolution at the RF Control Board. Reference: Section 6.10. Proper resolution exists on the logarithmic display when the valley between two approximately equal size peaks is one decade below the tops of those peaks.

6.12.3 The Local Mode *Calibrate* Function

Reference: QualiTorr Short Manual Instructions, Appendix D.

Pressing the Calibrate selection on the console while in the Main Menu display on the QualiTorr Remote starts the Calibrate process consisting of determining the exact location of mass peaks in the calibration gas and performing sensitivity calculations based on the total pressure and gas composition.

The operator tells the QualiTorr Remote which gas is to be used for calibration by selecting the appropriate gas label on the VGA Monitor. The operator is then instructed to inlet the calibration gas to a pressure determined by gauging on the process station. Assuming that the UTI Cal Gas is inlet to the suggested pressure, we will discuss the calibration at that pressure. Later, in the Sensitivity section, calibrations at other pressures will be discussed.

6.12.3.1 Local Mode Mass Peak Location

Reference: QualiTorr Short Manual Instructions, Appendix D.

Pressing Continue, after responding to the gas pressure inquiry, starts the process of locating the exact position of the top of each peak in the UTI Cal-Gas. In this process, the QualiTorr Remote starts a scanning process around each of the six peaks wherein the signal amplitudes are taken and compared starting 40% below the nominal location and running 40% above the nominal location of each mass peak. The comparison searches for the maximum amplitude and then stores the DAC driver value of the point at which the maximum was found. If the unit had been calibrated previously, the search routine centers around the DAC driver value stored from the last calibration, rather than the nominal value. This process continues until the DAC value has been found for each of the six peaks: 2, 4, 28, 40, 86, and 136 AMU. If any of the six peaks are too small or not located in this process, a message appears in blue background on the CRT: "Peak Height $< 1 \times 10^{-10}$."

Once the actual locations of these peaks are determined, they are used to interpolate (via slope and intercept) the location of all peaks between these six peaks and to extrapolate the location of the peaks beyond 129 AMU by using the slope and intercept determined from the location of the peaks at 86 and 136 AMU.

Upon completion of this automatic location-finding function, a VGA Monitor screen appears that allows the operator to choose between re-selecting the calibration gas and re-performing the location calibration, or to select the Sensitivity Calibration. If the automatic-peak locating function has been successfully completed, select Sensitivity Calibration to continue the calibration procedure. If the peak-locating procedure has not been successful, it may be necessary to repeat the Mass Peak Location and Mass Peak Resolution procedures in Sections 4.5.3.1 and 4.5.3.2.

6.12.3.2 Local Mode Sensitivity Calibration

Reference: QualiTorr Short Manual Instructions, Appendix D.

The Sensitivity Calibration is the process whereby the QualiTorr Remote is calibrated to the user's process station. There are two major parts of this function:

1. Setting the overall sensitivity of the QualiTorr Remote to have a direct correlation with the total pressure in the user's process station.

2. Setting the sensitivities of individual gas/mass peaks to correspond with known gas compositions.

In the previous section, we assumed that the UTI Cal-Gas had been inlet to a total pressure of 2×10^{-6} Torr in the user's process chamber. Here, we will address the means of monitoring and calibrating to the entire range of pressures likely encountered in a multitude of processes–i. e., how we move the portable window to view the process pressures ranging from atmospheric to ultra-high vacuum.

For pressures below 10^{-5} Torr, the monitoring is very simple because the sensor (probe)–with an Open Ion Source–can be inserted directly into the process chamber, and the QualiTorr Remote can be calibrated to read the same total pressure as a Bayard-Alpert gauge located in the process chamber.

For pressures above 10^{-3} Torr, it is necessary to extract a sample of the gases from the process chamber and analyze it. For process pressures between 10^{-5} and 10^{-3} Torr, a Closed Ion Source Probe can be used without any pressure reduction. The following procedure describes the relation between the partial pressures in the process chamber and those in the sensing element.

It is most desirable to be able to inject the UTI Cal-Gas into the process chamber at the pressure comparable to normal working process chamber pressures and measure that pressure with the process chamber pressure gauge while sampling the chamber via the UTI Sampling System. We will consider this ideal situation first and then consider the situation in which the UTI Cal-Gas is not available, but some other calibration gas such as argon or nitrogen is available.

Assume we have a process chamber of 7×10^{-3} Torr (7 milliTorr), and have entered the Calibrate function. We have chosen the UTI Cal-Gas and the QualiTorr Remote has completed its Location of the six mass peaks. We now select *Sensitivity Calibration* from the VGA Monitor screen.

We enter the maximum operating pressure we wish to view. This sets the maximum pressure decade on the display ordinate. Next, we enter the precise pressure of the Cal-Gas. We then select OK.

The QualiTorr Remote Station Controller now begins to change the electron multiplier voltage up or down until the peak at 28 AMU is 95% of 7×10^{-3} Torr, because nitrogen (primarily represented by the peak at 28 AMU) is 95% of the total gas composition. This sets the overall sensitivity of the QualiTorr Remote to have a direct correlation with the total pressure in the process chamber. A coefficient for total pressure is calculated and stored at this time.

The individual sensitivities of certain gas/mass peaks will now be set to correspond with their known composition. Here, we have chosen one single peak to represent each of the six gases in the Cal-Gas mix, as is listed in Table 4-3. Therefore, a number will be calculated for each of the five remaining peaks. This new number/coefficient will be multiplied by the actual signal from each of the peaks (2, 4, 40, 86, and 136 AMU) displayed on the VGA Monitor in the *Selected Peak Monitoring* mode so that each of the five peaks will have a value equal to: $0.07 \times 10^{-6} = 7 \times 10^{-8}$ Torr = 1%. The sensitivity coefficients for the remaining 194 (200-6) AMU locations are calculated and stored.

It is important to realize that Sensitivity Coefficients are used to modify the readout to the VGA Monitor only in the *Selected Peak Monitor* mode and Not in the *Static Scan* mode.

For calibration with single gases such as argon and nitrogen, see Appendix C.

6.12.4 Local Mode Leak Hunting

Reference: QualiTorr Short Manual Instructions, Appendix E and Figure 6-17

The QualiTorr Remote is a sensitive leak detector for use with selected tracer gases having a mass from 1 to 200 AMU. The detected pressure of the selected gas is displayed in bar graph and time profile format on the VGA Monitor. An optional hand-held monitor can also be used. A signal proportional to the pressure is sent to the hand-held monitor shown in Figure 6-17. This hand-held accessory provides remote leak level indication. The hand-held monitor emits a visible and audible indication of the detected gas. The UTI *Leak Hunter* also provides an output earphone jack.

To find leaks, a tracer gas, such as helium, is applied to the outside of the process chamber with a QualiTorr Remote probe installed. When the helium flows through the leak (moving from the outside of the vacuum system to the inside of the vacuum system), it is detected by the sensitive QualiTorr Remote probe that is monitoring the gases in the process chamber. By correlating the location of the applied sensing gas on the outside of the vacuum system with the detection of the sensing gas inside of the vacuum system, the vacuum leak can be quickly and easily located.

6.12.4.1 Leak Hunting with the (Optional) Hand-held Leak Hunter

Reference: QualiTorr Remote Host Computer Operating Instructions, Appendix E.

The hand-held *Leak Hunter,* shown in Figure 6-17, attaches to the front of the Station Controller. The *Leak Hunter* has a visible light indicator of the detected gas that lengthens from left to right across the top of the module as the detected pressure of the tracer gas increases. The indicator is logarithmic and illuminates one to thirty light-emitting diodes (LEDs) corresponding to a full-scale reading of two-times threshold (*Hi Sensitivity*, 2% signal change per LED) or 100-times threshold (*Lo Sensitivity*, 16% signal change per LED) level of the tracer gas. The *Volume* and *Pitch* controls vary the loudness and frequency of the audible sound indication of tracer gas detection. The pitch of the audible indicator increases with increasing tracer gas level. The pitch rises two octaves from threshold to full-scale.

The *Manual Threshold* control is a sliding potentiometer that sets the detection threshold of the *Leak Hunter*. The setting scale is logarithmic so a movement of the slide from 8 to 9 decreases the detection threshold by a factor of ten, corresponding to 10^{-8} to 10^{-9} Amps of detector current.

The *Auto* setting of the *Threshold* switch causes the *Leak Hunter* 's detection threshold to automatically track the level of tracer gas. This tracking is slow enough that it does not null-out leak hunting increases, but fast enough to compensate for vacuum system and background drift. The time constant is about 10 seconds. The *Reset* button momentarily zeros this time constant, causing an immediate update of the internal threshold setting

To install and confirm the operation of the *Leak Hunter*, follow these steps:

1. The Leak Hunt function is located by first selecting *Leak Hunt* with the Key Switch in the *Program* position.

2. Select the tracer gas that will be used. Set the *Leak Hunter* to *Auto Threshold* and *Lo Sensitivity*.

3. Since all of these gases are contained in the UTI Cal-Gas, it is simple to confirm the correct operation of the *Leak Hunter* by simulating a leak and monitoring its detection. If the probe is installed using the sampling module, close all inlet valves and fill the process chamber with UTI Cal-Gas to about 1/100 of the normal process pressure. If the open ion source probe configuration is used, inlet 10^{-9} to 10^{-6} Torr of the Cal-Gas into the process chamber and proceed to Step 7.

4. While the inlet valves are closed, monitor the background level of the tracer gas and press *New Threshold* on the Control Console to reset the background level to the current tracer pressure. The new range displayed on the Console CRT will be one to two decades above the background level.

5. Open the inlet valve of the smallest orifice and note if the tracer gas is detected by the QualiTorr Remote.

6. The sensing gas level should be displayed on the Console and the light display on the top of the *Leak Hunter* should advance from left to right across the display. If the *Leak Hunter* doesn't respond, turn the sensitivity to *Hi* and check the Control Console to see if the tracer gas is being detected there. If no signal is detected (open ion source), increase the process chamber pressure. If no signal is detected (closed ion source), either open the inlet valve leading to a larger orifice or close all of the inlet valves and increase the pressure of the tracer gas in the process chamber and repeat the procedure from Step 4. If the signal is swamping the detector (open or closed ion source), decrease the pressure in the process chamber and repeat the procedure from Step 4.

7. If the *Leak Hunter* is responding to the tracer gas, turn the Threshold switch to Manual (Man) and set the slide switch so that only one or two LED segments are lit at the left side of the display. Then, either increase the pressure in the process chamber or open the valve leading to a larger orifice to let more tracer gas into the sampling module (thereby simulating a vacuum leak). The pitch of the Leak Hunter should rise and the light display should lengthen toward the right.

8. Confirm that the *Pitch* control changes the audible frequency and the volume control works correctly.

9. With the Leak Hunter at HI sensitivity and the threshold control switch set to Manual, adjust the slide-potentiometer control setting to turn On all of the LEDs, except the one on the far right. Switch to LO sensitivity and confirm that only about six LED segments remain On. Confirm that the *Sensitivity* switch changes the full scale indication by a factor of 50.

10. Confirm that leak indications slowly decrease in the AUTO THRESHOLD mode. Also, confirm that pressing the RESET button instantaneously brings the threshold setting up to that of the tracer, thereby nulling out any current leak indication.

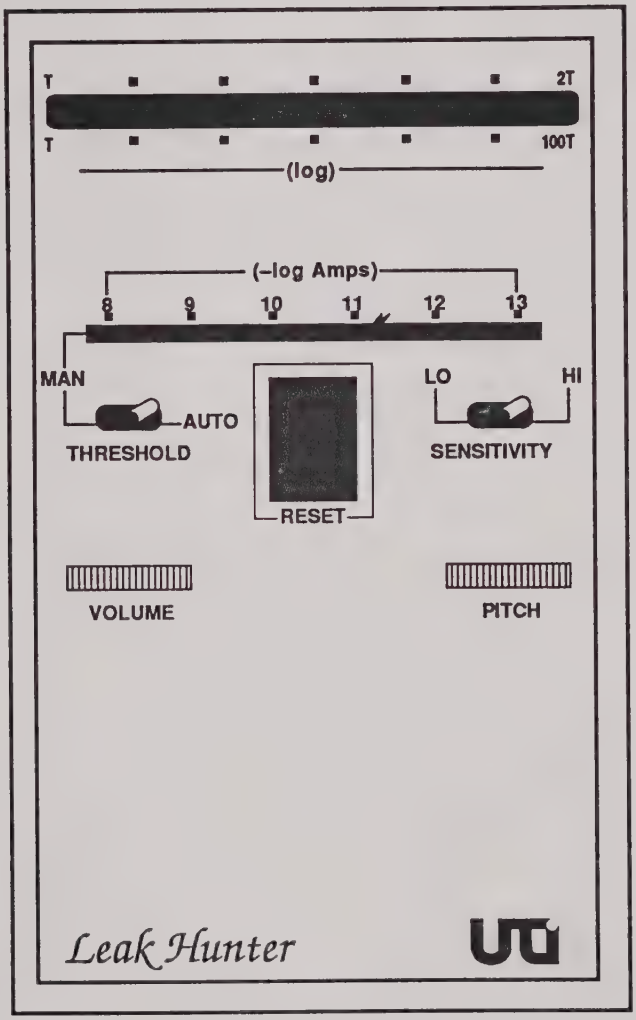


Figure 6-17. The QualiTorr Remote Leak Hunter Accessory

Chapter 7

General Maintenance

This chapter provides the routine maintenance schedule and procedures that must be performed to ensure continued trouble-free performance of the QualiTorr Remote System. Section 7.1 groups maintenance tasks by the frequency that they should be performed. Specific tasks should be conducted daily, monthly, six monthly, and yearly. This section also references the user to the sections in this manual where the required procedures are described. Section 7.2 provides the step-by-step routine maintenance procedures for the mechanical and turbomolecular pumps as well as how to clean the probe. For ionizer filament replacement, see section 5.4.

7.1 Maintenance Schedule

> NOTE
>
> It is highly recommended that the user keep a daily chronological maintenance log that monitors system use. Entries should include the date, operators name or initials, a description of any maintenance procedures performed, notes pertaining to any symptoms or observations concerning system performance, and notes concerning the process gases used.

7.1.1 Daily

Open source probe configuration: No daily tasks required.

Closed source probe configuration: Perform the daily tasks described in Section 7.1.1.1. If you have a system that has one or more pneumatic sampler inlet valves, also perform the task described in Section 7.1.1.2.

7.1.1.1 Mechanical Pump

Reference: Figures 7-1 and 7-2.

Some applications, such as ion implantation, chemical stripping, and etching systems, may require weekly pump oil changes or more extensive trapping systems to eliminate or reduce pump oil contamination.

To maintain the mechanical pump, follow these steps:

1. Check the pump oil level to ensure that it is visible and in the sight glass window. The exact level of the pump oil is best determined when the mechanical pump is off. The pump oil level should be between the minimum and maximum marks on the sight glass. If the level is not visible or low, it will require that additional oil be added. To add oil, proceed to Section 7.2.1.

2. The pump oil should be clear, transparent, and slightly amber in color. If the oil appears discolored or cloudy, it should be replaced. To change the oil, proceed to Section 7.2.1.

7.1.1.2 Pneumatic Valve Gas Pressure

To maintain the gas pressure, follow these steps:

1. Check the regulator gas pressure to ensure that the valve has a pressure between **110 and 120 psi** to ensure proper activation. **This is a critical requirement.**

2. Check the regulator's high pressure gauge to ensure that sufficient pressure is available for the day's work. If the gas pressure is getting low, it may be time to order a new cylinder of gas. Depending upon the frequency of use of the pneumatic valves, it is often useful to have one cylinder for backup to ensure that possible delays in gas delivery do not affect processing and analyses schedules.

7.1.1.3 Data Quality

To ensure that the process data quality remains high, follow these steps:

1. Check the previous day's data for reproducibility and accuracy. Is the mass location and resolution as well as the sensitivity adequate for your analyses? If adjustments are required, proceed to Chapter 6.

2. Look at the previous day's spectra. Can you account for all of the peaks that the QualiTorr Remote is detecting? If the system appears contaminated, an overnight bakeout may significantly help in the quality of the analysis data and simplify interpretation of the results. If a system bakeout is required, proceed to Section 4.3.6.

7.1.2 Monthly

Open source probe configuration: Perform the tasks described in Sections 7.1.2.1 and 7.1.2.2. The bakeout described in Section 7.1.2.3 should only be performed if the mounting geometry allows a heating mantle to be used.

Closed source probe configuration: Perform the monthly tasks described in all of the sections.

7.1.2.1 Vacuuming

To ensure that the electronic cooling systems do not become clogged with dirt and dust, follow these steps:

1. Vacuum the front and back of the console and surrounding area to remove dirt and dust that can be pulled into the console from the cooling air fan.

2. If your turbomolecular pump uses air cooling, vacuum the air blower mounted on the TMP.

3. Vacuum around the TMP electronic controller and the mechanical pump to reduce the dust level around the QualiTorr Remote analysis area.

7.1.2.2 Electron Multiplier Gain

To ensure that the electron multiplier is working properly, follow this procedure:

Check the multiplier gain as a function of the electron multiplier supply voltage to produce this gain. Since the QualiTorr Remote does not measure gain in the conventional manner of measuring input/output ratios, gain in this case refers to being able to reach adequate peak height values before the electron multiplier high voltage power supply reaches its upper limit of 3000 VDC. Input/output ratios can be measured, if needed, by using a jumper to activate the Faraday Cup. (See Section 9.3.4.2 for information regarding the use of the Faraday Cup.) The average life expectancy for an electron multiplier is typically one year. However, the lifetime of each electron multiplier is extremely dependent upon the operating environment provided by your process. High halogenic, hydrocarbon, or moisture levels have an extremely detrimental affect on the lifetime of the electron multiplier.

7.1.2.3 Bakeout

To ensure that the vacuum system remains clean, a system bakeout must be performed at least once a month, usually over night. Ideal bakeout conditions consist of a probe pressure range of 10^{-5} or lower, turbomolecular and mechanical pumps running, inlet and sampler heating mantles turned on, turbomolecular pump heater on, and a slow purge gas leaked into the system, such as argon or nitrogen, to provide a purging or flushing action. The probe filaments should be On and the electron multiplier should be Off. **Enter 0 volts for the electron multiplier voltage.** The detailed bakeout procedure is provided in Section 4.3.6. The molecular sieve trap on the pump foreline is always baked out separately and usually less often than the system. It requires that the TMP, filaments, and multiplier are Off. The foreline valve must also be closed.

7.1.2.4 Cooling Connections

Air cooling is standard on most UTI-supplied turbo molecular pumps, however, if the you have a turbomolecular pump that is water cooled, then it is necessary to confirm that the inlet and outlet hoses are in good condition and are not crimped or clogged in any way. Ensure that a continuous flow of approximately 4 gal/hr (15 l/hr) is being emitted at the cooling drain, that the drain is not clogged, and that the temperature of the water entering the TMP from the input hose is approximately 15 °C.

7.1.3 Six Monthly

Open source probe configuration: No six-monthly tasks required.

Closed source probe configuration: Perform the six-monthly task described Sections 7.1.3.1 and 7.1.3.2.

7.1.3.1 Mechanical Pump Oil Change

The minimum frequency that the mechanical pump should be changed is once every six months. More frequent oil changing is necessary if the pump is used in contaminated or dirty systems or processes. Proceed to Section 7.2.1.

7.1.3.2 Recalibration of System

To ensure that the QualiTorr Remote continues to perform at a high level of performance, it is highly recommended that the electronics be retuned at least once every six months. This consists of a complete analysis of the check and test points, as well as corrective tuning and adjustment, as required. A recalibration of the system is required after the retuning procedure. Proceed to Chapter 6 for a detailed explanation of the test points and adjustments that are required for each board. When the performance adjustments are completed, proceed to Section 4.5.3 and complete a system calibration.

7.1.4 Yearly

Open source probe configuration: No yearly maintenance is required.

Closed source probe configuration: Perform the yearly task described in Section 7.1.4.1.

7.1.4.1 Turbomolecular Pump Oil Change

To ensure continued high performance of the turbomolecular pump, the bearing lubrication oil must be changed at intervals of 5000 operating hours, or after a period of a year, whichever comes first. Proceed to Section 7.2.2.

7.2 Maintenance Procedures

The procedures that follow consist of the most common routine maintenance procedures. If additional, more detailed, information is required, the user should contact the referenced operation and maintenance manuals.

7.2.1 Mechanical Pump Oil Change

7.2.1.1 Alcatel 2004B (3.2 CFM)

Reference: Alcatel Mechanical Forepump Type 2004B and Figure 7-1.

The suggested pump oil change schedule requires changing the pump oil after its initial 100 hours of operation following installation. The recommended frequency of oil changes after the initial change is every six months, and then after any major overhaul of the pump. It should be noted that more frequent pump oil changing will be necessary if the pump is used in contaminated or "dirty systems", or in cases involving highly corrosive gases. The pump oil should be visually checked periodically to observe any pump oil discoloration by viewing into the oil sight port. Pump oil should remain clear and transparent. If it is discolored or cloudy, then it needs to be changed.

To change the pump oil, follow these steps:

1. Turn the the ball valve between the metal vacuum hose and the molecular sieve trap to Off (horizontal position). See Figure 4-2. This isolates the backing system from the turbomolecular pump and sampler system and prevents the mechanical pump's oil vapors from backstreaming and allowing hydrocarbons to enter and contaminate the TMP, sampler, and probe system.

2. Run the pump for one hour prior to shutting it off to heat the oil. Then, remove the power cord from the source power. An extension tube for the oil draining is supplied separately in a pack from Edwards.

3. Vent the pump to the air.

4. Disconnect the pump from the system by removing Clamp A (see Figure 4-2). Wrap the vacuum fitting on the molecular sieve side with aluminum foil, a lintless cloth, or an equivalent cover to prevent contamination while it is exposed.

5. Unscrew the drain plug on the oil case, tilt the pump, and drain the oil into a clean container. Once the oil has drained out of the oil case, replace the drain plug temporarily and run the pump for approximately 10 seconds leaving the inlet open. This drives all of the remaining oil out of the pumping system.

6. Drain the remaining oil by unscrewing the drain plug and tilting it again.

7. If the oil appears cloudy (a sign that condensables are being absorbed), it can often be regenerated with a gas ballast; proceed to Step 8. When oil appears brown, blackish, or smells "burnt" it probably has deteriorated. If the oil has deteriorated or appears particularly dirty, proceed to Step 9 to flush the pump out before adding fresh oil. If the oil is slightly discolored, it probably just needs to be replaced; proceed to Step 10.

8. To regenerate the oil by use of a gas ballast purging procedure, replace the drain plug and pour the cloudy oil back into the pump. Block the inlet port with a plug or rubber stopper and start the pump and run the pump for one hour. Then, without stopping the pump, open the gas ballast wide open and let the pump run for an additional hour. This procedure expels most condensable products. If the condensables are toxic or radioactive, appropriate ventilation precautions should be made to vent the products safely. If the pump oil clears and is no longer cloudy, proceed to Step 11. If the pump oil does not clear, replacement of the pump oil is recommended. Repeat Step 7.

9. If the pump is extremely dirty and requires flushing, follow these steps:

   a. Replace drain plug and clean or replace inlet filter. Place a cloth lightly over the exhaust port to contain any oil splashes and turn the pump on for about 10 minutes with its inlet open to atmospheric pressure. Then, remove the cloth and slowly pour fresh oil into the inlet equal to the pump's capacity. Alcatel VP1 Pump Oil is recommended for recharging or flushing the pump, but the other oils given below are also suitable

   b. Turn off the pump again, remove the drain plug, and drain the dirty flushing oil. Replace the drain plug. Proceed to Step 10.

10. Fill the pump with fresh oil to the level where it is in the middle of the glass oil sight port, midway between the minimum and maximum level indicators. The recommended pump oil type is ALCATEL VP1 or 100. Other suitable oil choices include the following: SHELL TALPA 30, ELF MOVIXA PV 100, and ESSO TERESSO 100. For applications that require that large amounts of oxygen be pumped through the mechanical pump, Fomblin® Y-25 oil is recommended (oxygen service is typically assumed when pumping gases contain more than 30% oxygen). **Oils such as triaryl phosphate esters are dangerous and should not be used.** Pump oil quality is extremely important for maintaining proper pump operating conditions.

11. Move the pump back to its normal operating position, remove the cover that you placed over the vacuum fitting, and connect the pump to the rest of the system by reinstalling Clamp A (see Figure 4-2).

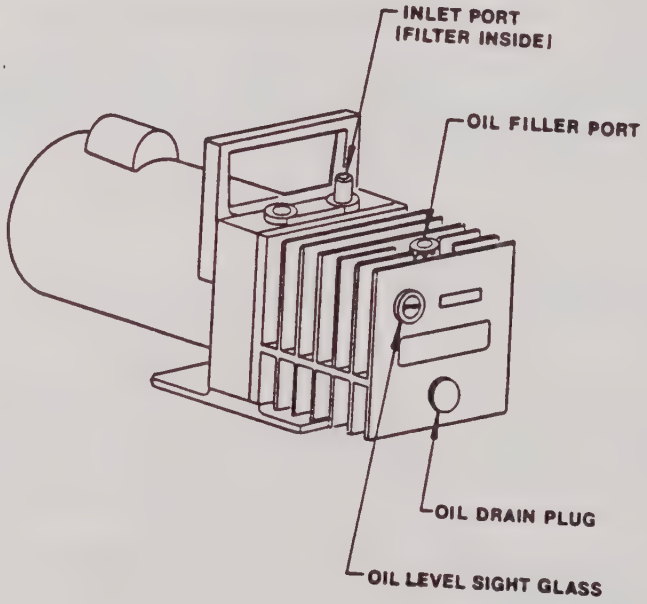


Figure 7-1. Alcatel Model 2004B (3.2 CFM) Mechanical Pump

7.2.2 Turbomolecular Pump Oil Change

7.2.2.1 Balzers Model TPU 060

References: Balzers Operating Instructions for the TPU 060 and Figure 7-2

Each TPU 060 Turbomolecular Pump is shipped from the UTI manufacturing facility filled to its proper level with TL 011 pump oil. Every TPU 060 turbo pump is filled with approximately 10 cc of TL 011 prior to its initial operation at the factory (the TPU 060 turbomolecular pump **cannot use** a Fomblin®-type pump oil). The life expectancy of TL 011 hydrocarbon pump oil is two years if the turbomolecular pump is not operated.

This initial pump oil filling remains within the turbomolecular pump throughout shipping, and an oil change must be performed after approximately 5000 hours of operations, or annually if the turbomolecular pump is not operated continuously (this oil replacement guideline for the turbomolecular pump is also very much dependent upon what types or classes of gases that the QualiTorr Remote System samples and monitors).

To change the oil, follow these steps:

1. Stop the TPU 060 and mechanical pump.
2. Vent the TPU 060 to atmospheric pressure.
3. Disconnect the metal vacuum hose at Clamp F (see Figure 4-2) and remove the turbomolecular pump; see Section 5.5.
4. Place the pump upside-down on its high vacuum flange on a clean dust-free surface.
5. Remove the pump's bottom cover (part 21) and wick holder (part 23).
6. Using tweezers or needle-nosed pliers, remove the old felt washer (part 18).
7. Hold the wick holder (part 23) over a bowl or suitable container. Using a syringe, continuously fill the upper slot of the wick holder with approximately 10 cc of fresh TL 011 pump oil.

> **CAUTION**
>
> **Assume that any pump oil that has dripped into the container is contaminated. DO NOT use contaminated oil to fill the wick holder. Avoid contamination of the oil.**

8. Saturate a new felt washer (part 18) with new TL 011 pump oil and insert it with its darker side facing the ball bearing. This felt washer must be replaced every time that pump oil is changed.

9. Insert the wick holder (part 23) back into its receptacle in the pump bottom. Ensure that the O-ring (part 4) is in the correct position.

10. Screw in the bottom cover (part 20), after first ensuring that the compression spring (part 13) and the O-ring (part 5) are properly seated.

11. The TPU 060 turbomolecular pump is now ready to resume normal operation.

12. Replace the TMP by reversing the removal procedure. Reference: Section 5.5.

13. Connect the metal vacuum hose at Clamp F. See Figure 4-2.

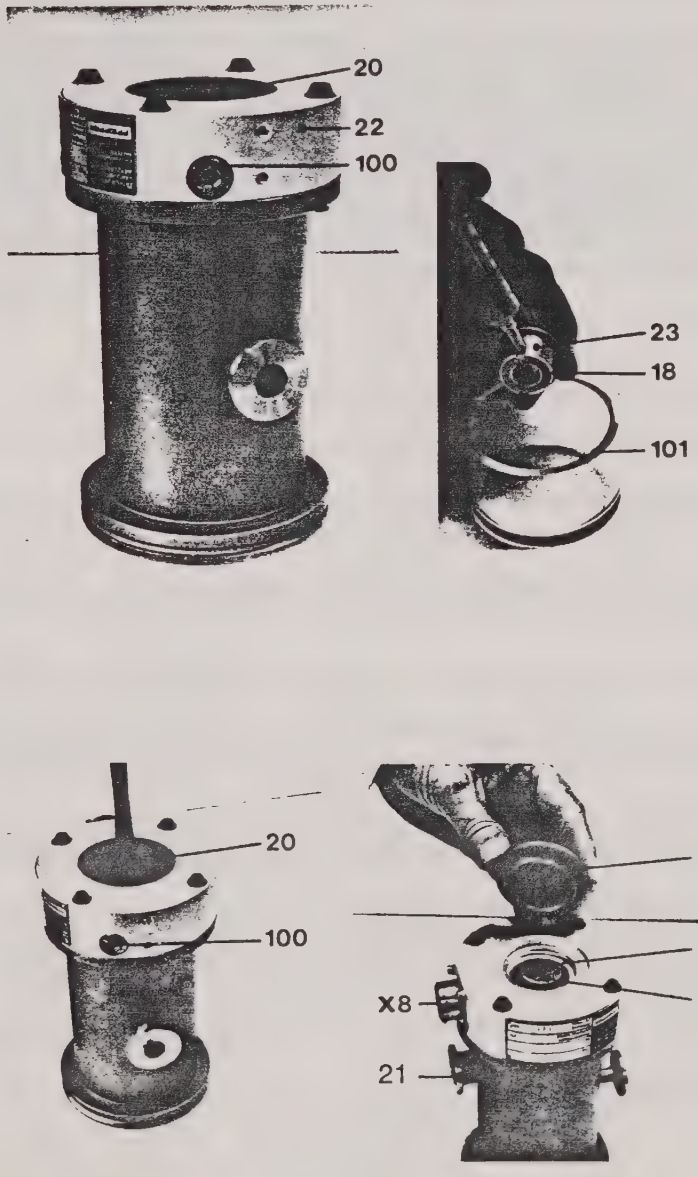


Figure 7-2. Turbomolecular Pump Oil Changing Procedure (TPU 060)

7.2.2.2 Alcatel Model 5081UHV

References: Alcatel Instruction Manual–Turbomolecular Pumps and Turbopak Type 5080-5100 with CFF100 and Figure 7-3

Each Alcatel Model 5081UHV Turbomolecular Pump is shipped from the UTI manufacturing facility filled to its proper level with Alcatel Grease. This initial pump oil filling remains within the turbomolecular pump throughout shipping, and an oil change must be performed after approximately 500 hours of operations, or annually if the turbomolecular pump is not operated continuously (this oil replacement guideline for the turbomolecular pump is also very much dependent upon what types or classes of gases that the QualiTorr Remote System samples and monitors). The TMP has two ball bearings that must be relubricated. You must use only Alcatel grease in the syringe and perform this maintenance procedure in a clean environment.

To change the grease, follow these steps:

1. Stop the 5081UHV and mechanical pump.
2. Vent the 5081UHV to atmospheric pressure.
3. Disconnect the metal vacuum hose at Clamp F (see Figure 4-2) and remove the turbomolecular pump; see Section 5.5.
4. Place the pump upside-down on its high vacuum flange on a clean dust-free surface.
5. Remove the pump's bottom cover by removing two screws. See Figure 7-3 (top).
6. Remove the washer and spacer. On pumps with serial numbers from 90077 to 90078, the spring washer has been replaced with a compression spring.
7. To lubricate the ball bearing opposite the pumping unit, deliver approximately 0.05 cc of grease into the ball bearing using the syringe. See Figure 7-3 (bottom).
8. To lubricate the ball bearing nearer to the pumping unit, insert the syringe through the screw to the end of the axle. The syringe must strike against the head of the screw. See Photo 4.3 in the instruction manual for further clarification.
9. Deliver approximately 0.12 cc of grease into the orifice with the syringe.
10. Remove the syringe.

11. Reassemble the spacer and the washer.

12. Replace the bottom cover and attach using the two screws.

13. The 5081UHV turbomolecular pump is now ready to resume normal operation.

14. Replace the TMP by reversing the removal procedure. Reference: Section 5.5. However, before reconnecting the mechanical pump, the manufacturer recommends that the TMP be run at atmospheric pressure with cooling for 7 minutes. If the thermal protection switch shuts the TMP off during the 7-minute procedure, the red light will come on. If this occurs, start the pump and use the following TMP On/Off cycles: On for 1 minute, Off for 15 minutes, On for 3 minutes, Off for 15 minutes, On for 15 minutes, and Off for 15 minutes.

15. Connect the metal vacuum hose at Clamp F. See Figure 4-2.

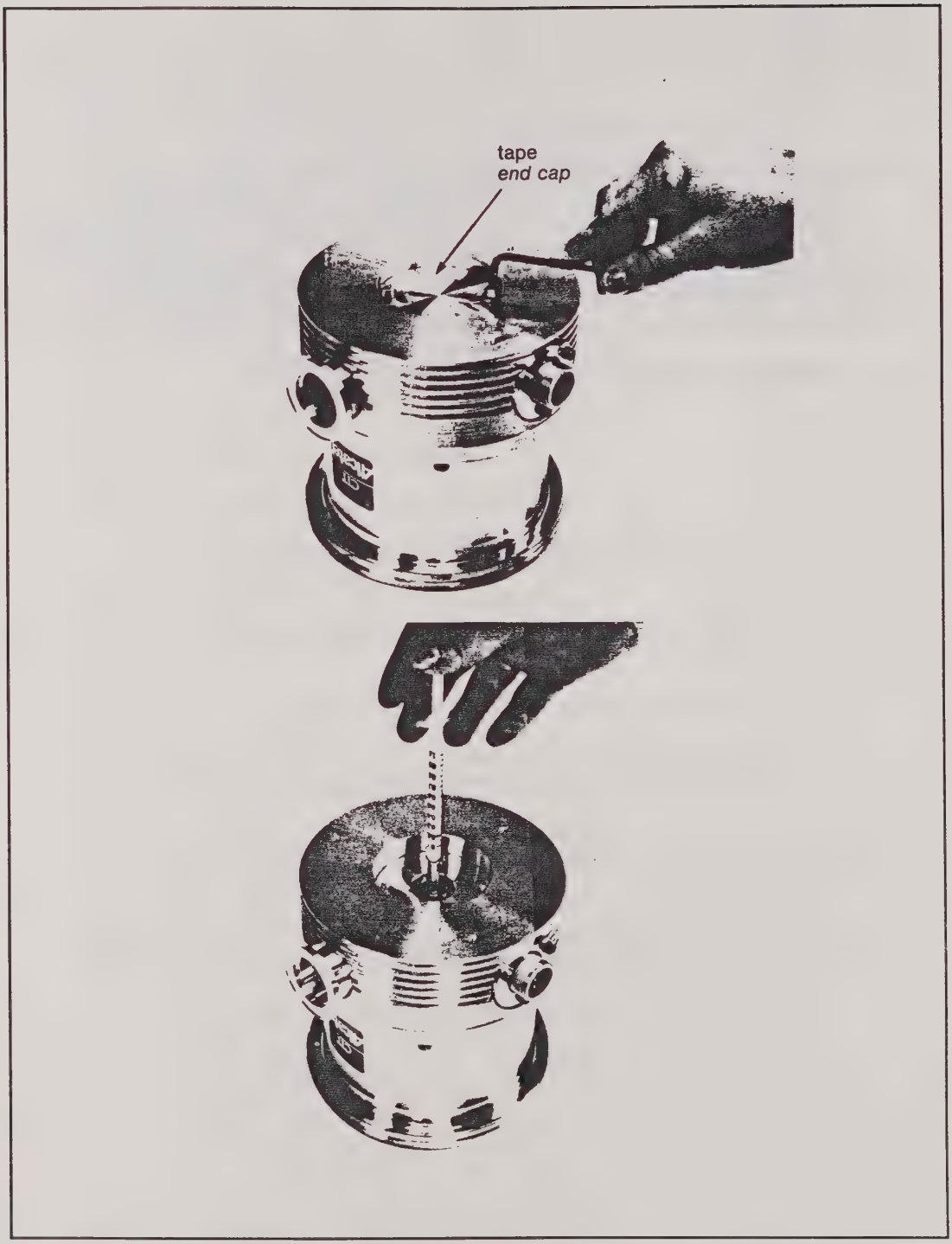


Figure 7-3. Turbomolecular Pump Oil Changing Procedure (5081UHV)

7.2.2.3 Balzers Model TPU 240

References: Balzers Operating Instructions for the TPU 240 and Figure 7-4

Each TPU 240 Turbomolecular Pump is shipped from the UTI manufacturing facility filled to its proper level with TL 011 pump oil. Every TPU 240 turbomolecular pump is filled with approximately 6 cc of TL 011 prior to its initial operation at the factory. The life expectancy of TL 011 hydrocarbon pump oil is two years if the turbomolecular pump is not operated.

This initial pump oil filling remains within the turbomolecular pump throughout shipping, and an oil change must be performed after approximately 500 hours of operations, or annually if the turbomolecular pump is not operated continuously (this oil replacement guideline for the turbomolecular pump is also very much dependent upon what types or classes of gases that the QualiTorr Remote System samples and monitors).

To change the oil, follow these steps:

1. Stop the TPU 240 and mechanical pump.

2. Vent the TPU 240 to atmospheric pressure.

3. Disconnect the metal vacuum hose at Clamp F (see Figure 4-2) and remove the turbomolecular pump; see Section 5.5.

4. Unscrew the four filler plugs (part 18).

5. Position the TMP horizontally over a drain pad so that two of its four oil wick chamber holes face upwards, while the remaining two wick chamber holes face downwards towards the drain pan.

6. Using a syringe, deliver approximately 20 cc of TL 011 turbomolecular pump oil (or Fomblin® 06-6 pump oil, depending upon your preference and requirements) as continuously as possible into each one of the two upper oil wick chamber holes. This step requires approximately 5 minutes to complete.

7. The "old/used" oil that drains from the two lower oil wick chamber holes is collected in the drain pan. Be sure to dispose of this used pump oil so that it will not be used again.

8. The used pump oil volume collected in the drain pan should approximate the volume that was used to refill the turbomolecular pump oil chamber.

9. Re-install the four filler plugs for the pump oil wick chambers.

10. The TPU 240 turbomolecular pump is now ready to resume normal operation.

11. Replace the TMP by reversing the removal procedure. Reference: Section 5.5.

12. Connect the metal vacuum hose at Clamp F. See Figure 4-2.

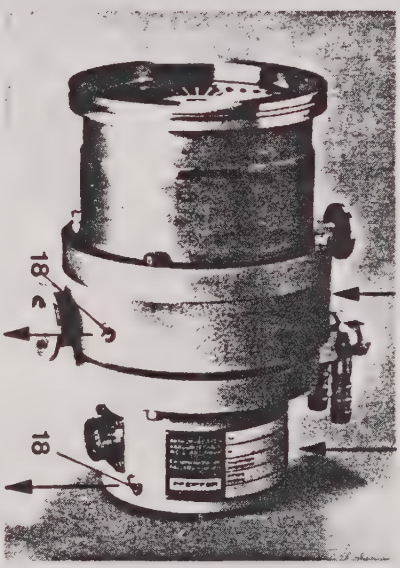


Figure 7-4. Turbomolecular Pump Oil Changing Procedure (TPU 240)

7.2.3 Probe Cleaning

To clean either the open or closed source probe, follow these steps:

1. Remove the probe from the vacuum chamber that houses it. **Be Extremely Careful Not To Break A Flange Feed-Thru.** Reference: Section 5.3.

2. Remove the probe support tube surrounding the filter assembly.

3. Thoroughly clean the probe support tube using acetone with Kim–Wipes or equivalent lint-less absorbant tissue.

4. Thoroughly clean the rod–filter section of the probe assembly using acetone soaked Kim–Wipes, *being extremely careful* not to scratch the filter rods or to allow any acetone to drip onto the electron multiplier.

5. Position the probe assembly with flange end up (to further avoid any liquid contact with the electron multiplier). Rinse with flowing acetone (from a squirt bottle), followed with a methanol rinse. Rinse the probe support tube in the same fashion.

6. Following reassembly, the entire probe assembly and its respective chamber should be baked out to remove any remaining volatiles such as the acetone, methanol, as well as any water that was absorbed by these solvents. See Section 4.3.6.

Chapter 8

Computer Maintenance

This chapter describes the maintenance of the computers used in the QualiTorr Remote System. There are two computers in the System—the Station Controller and the Host Computer.

A key diagnostic when operating in the Host Computer Mode is provided by the "Ready" light located at the center of the Station Controller's front panel. The "Ready" light indicates that the Station Controller is in one of four states. The four states are described in Table 8-1.

Table 8-1 Station Controller Ready Light (Host Mode Only)

Ready Light Characteristics	Analyzer Status
Fast Regular Blinking (Once Per Second)	Remote Station ready, but **not** communicating.
Irregular Blinking	Remote Station Controller's Computer is in communication with the Host Computer.
Light On (Steady) or Off	Station Controller's Computer is not functioning.
Very Slow Blinking	Station Controller's Computer is collecting data.

8.1 Station Controller

The computer system in the Station Controller consists of the CPU Mother Board (with its 80286 CPU and ROM BIOS), Analog/Digital I/O Board, Disk Drive Controller Board, Serial/Parallel RS-485 Board, Video Graphics Adapter (VGA) Board, and Floppy Disk Drive. The Subsystem Interaction Diagram, Figure 9-2, shows the relationships of the Station Controller's components.

Computer maintenance on the Station Controller is conducted in either of two test configuration modes.

- ❑ Local Mode
- ❑ PC Mode

8.1.1 Local Mode

Operation of the Station Controller in *Local Mode* allows it to be tested without connection to the Host Computer. In Local Mode, computer maintenance is conducted with a VGA monitor and an AT keyboard connected directly to the Station Controller using the jacks on the front of the Controller. No Host Computer is used in Local Mode. By removing the Computer Host from the maintenance configuration, testing can be performed to confirm the operation and performance of the QualiTorr Remote Station (Station Probe and Station Controller). The test configuration is shown in Figure 8-1.

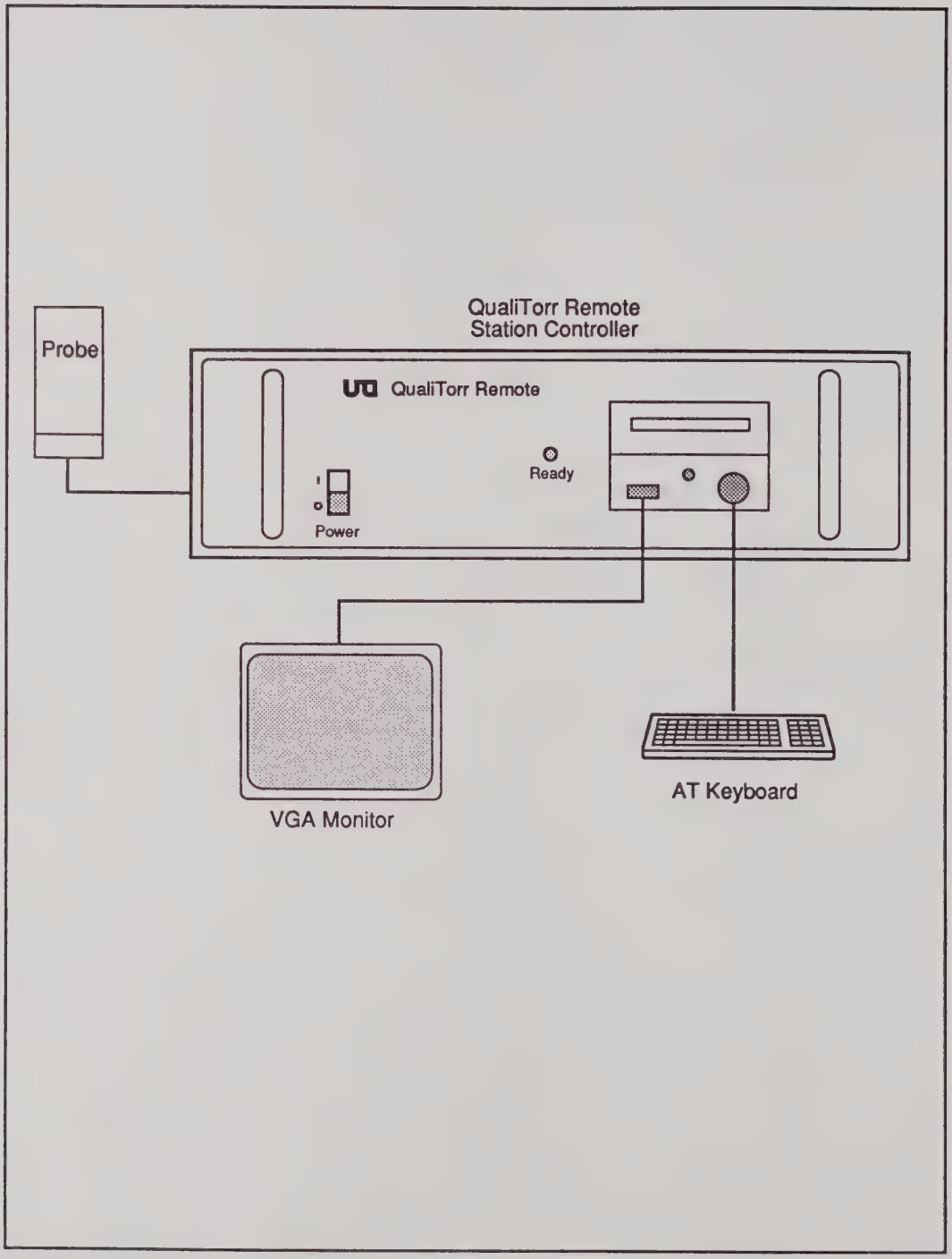


Figure 8-1. Local Mode Operation of the
QualiTorr Remote Station (Station Probe and Station Controller)

In order to perform computer maintenance in the Local Mode, the QualiTorr Station Controller is booted using the "QualiTorr Remote (QTRT) Local Disk." The diskette is inserted and the Station Controller is powered *On*.

Standard QualiTorr III operation is provided by use of the keyboard and the VGA monitor, as shown in Figure 8-2. Use keyboard keystrokes F1-F6 Function Keys for Control. Additional keyboard commands are

"Escape" = Exit

Backspace = Correction

K = Key Switch Toggle: Run/Program (Prog)

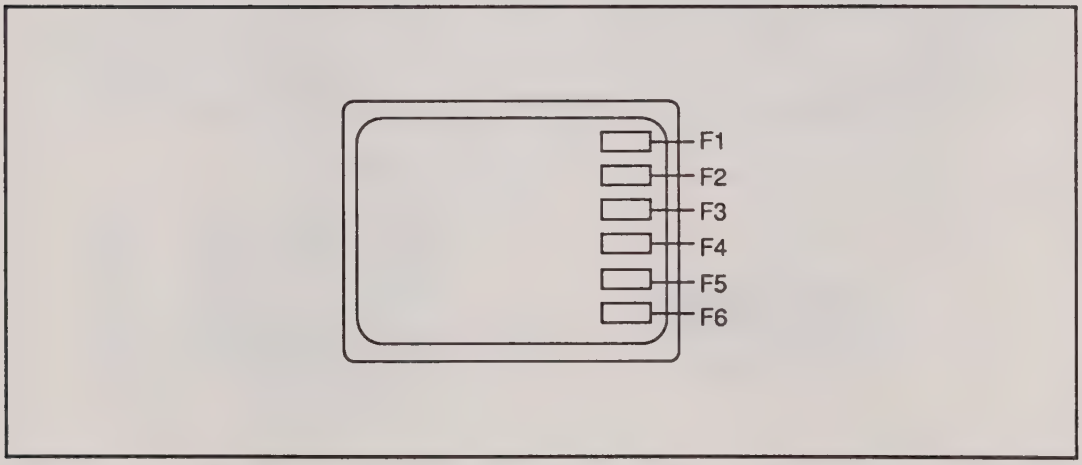


Figure 8-2. AT Keyboard Operation of the QualiTorr Station (Station Probe and Station Controller) in Local Mode

8.1.2 PC Mode

Operation of the Station Controller in PC Mode allows it to be tested without connection to the Station Probe *or* Host Computer. Computer maintenance on the Station Controller may be conducted with a VGA monitor and an AT keyboard connected directly to the QualiTorr Analyzer using the jacks on the front of the Controller. No Station Probe or Host Computer is required. By removing the Computer Host and the Station Probe from the maintenance configuration, testing can be performed to confirm the operation and performance of the Station Controller.

In the PC Mode, the Station Controller's computer is software configured as a standard IBM-PC compatible AT system. By booting from Floppy Drive A, industry standard diagnostic software may be run on the system. The test configuration is shown in Figure 8-3.

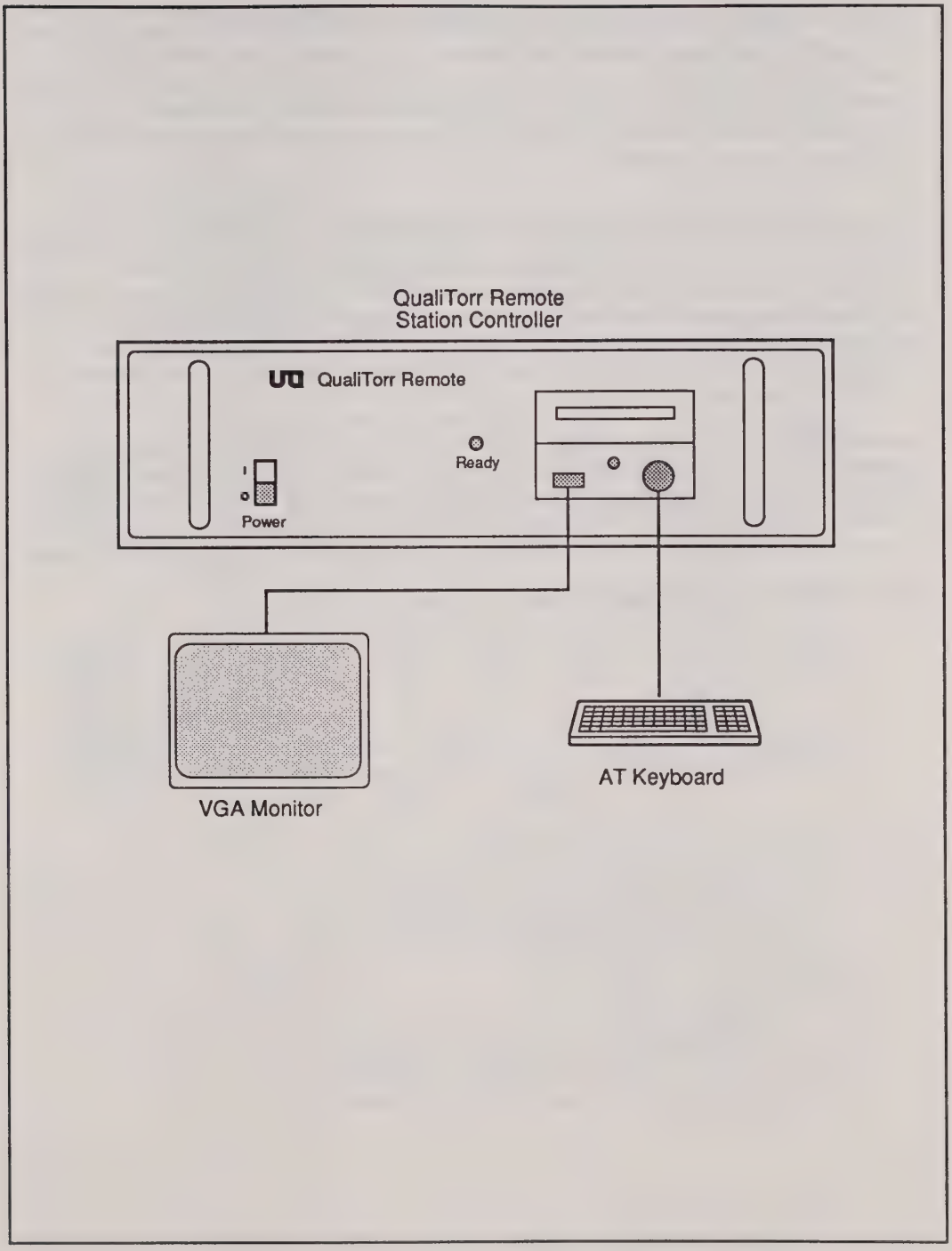


Figure 8-3. PC Mode Computer Maintenance of the QualiTorr Remote Analyzer

8.1.3 Station Controller CPU Mother Board (80286)

The standard configuration QualiTorr Remote uses a 80286-12 mother board. This board is 100% IBM PC/AT compatible and accepts standard ISA AT option cards. The motherboard and associated option cards are industry standard replaceable components. Jumper settings for individual boards are set at the factory and will require no change in the field.

8.1.4 Station Controller Analog/Digital I/O Board

The Analog/Digital Input Output (A/DI/O) Board links the QualiTorr Remote Instrument electronics to the Central Processing Unit (CPU). The DIO resides directly on the computer system bus; it optically isolates the digital system bus from the equipment analog electronics. The DIO provides the CPU with equipment status information and passes CPU control onto the equipment through optically isolated current sink and source circuits.

In addition, a 10 MHz opto-isolated pulse counter circuit and variable frequency generator (Pulse Simulator) are implemented on the DIO. The pulse counter performs the function of counting input pulses up to a pre-programmed maximum time period or count. The pulse simulator is utilized in the diagnostics mode to generate pulse streams that are counted and displayed without the need for connecting a probe to the equipment.

The Analog/Digital I/O Block Diagram is shown in Figure 8-4.

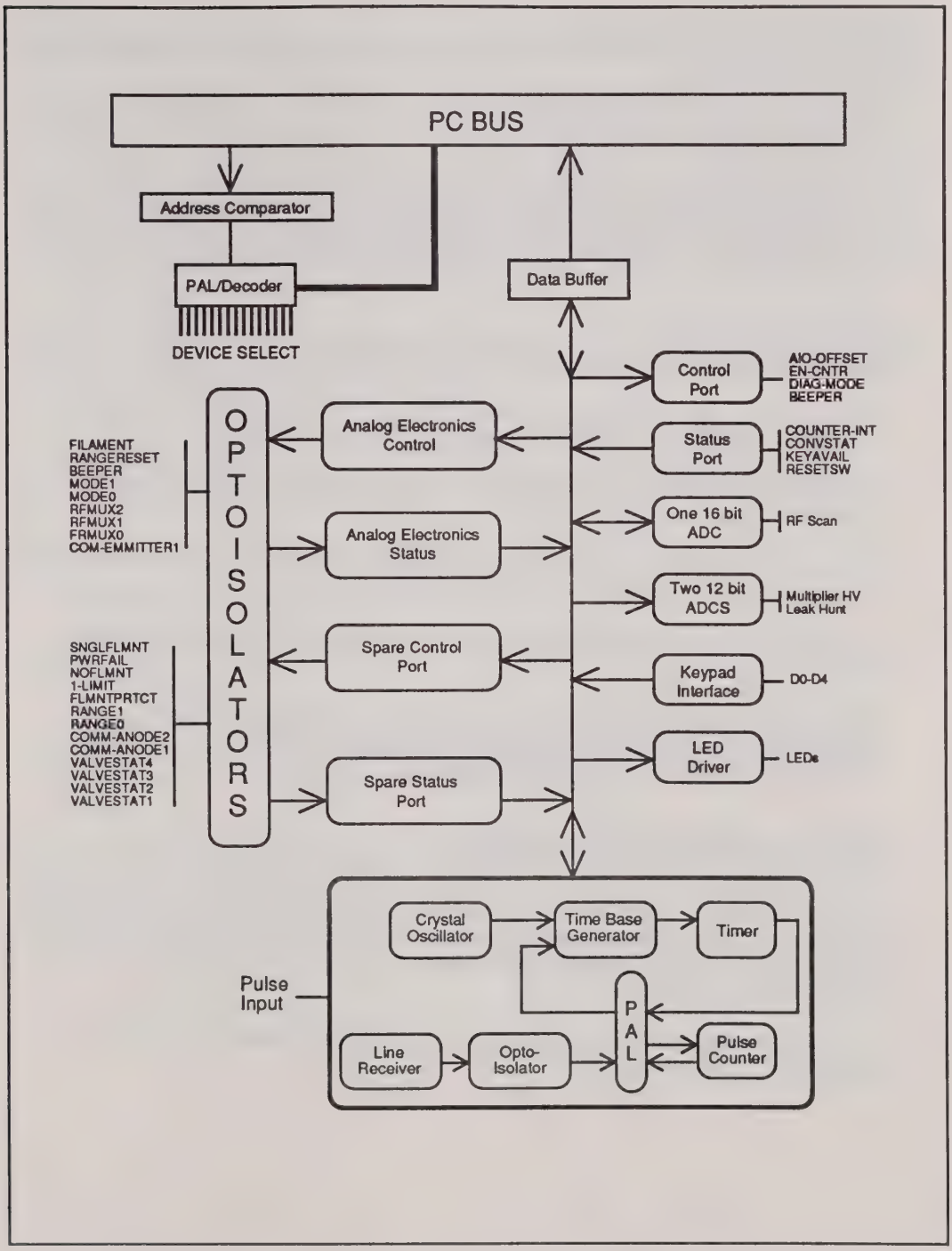


Figure 8-4. Digital/Analog I/O Block Diagram

8.1.4.1 Hardware Description

8.1.4.1.1 Bus Interface

An address comparator (74LS688), a PAL and a data transceiver interface the PC bus to the DIO circuits are described below.

8.1.4.1.2 AIO Interface

The system CPU communicates with the AIO through an 8-bit data transceiver, 4-bit data buffer (D08-D11), twelve direct control bits (GAIN & MUX), in addition to seven select and timing control signals such as two block select lines, three address lines, IORD and IOWR signals.

8.1.4.1.3 Pulse Counter

The pulse counter circuit consists of the following block:

- Line Receiver: A 75122 line receiver is utilized at the PULSE INPUT in order to minimize signal losses by properly matching the line impedance.
- Optical Isolator: Maintain power and ground isolation between the analog electronics and the digital circuits.
- Programmable PAL: Programmable Array Logic controlling when the timers and counters start and stop.
- Crystal Oscillator: Provides a base frequency for the timers and the diagnostics dividers.
- Programmable Dividers: Two 8254s, each including three 16-bit dividers, are utilized for Input pulse counting, Elapsed time measurement, and to simulate the input pulse stream in the diagnostics mode.

8.1.4.2 Analog Electronics Interface

Two 8-bit opto-isolated input ports and one 8-bit opto-isolated output port are utilized for the Analog Electronics Interface. Each input port bit consists of a series resistor, and opto-isolator, a pull-up resistor, and TTL tri-state buffer (1/8 of a 74LS244) connecting it to the local data bus. Each output bit consists of a latch (1/8 of a 74LS374), a series resistor, and an opto-isolator.

In addition, one 8-bit opto-isolated input port and one 8-bit opto-isolated output port are available for future expansion.

8.1.4.3 Operation

8.1.4.3.1 Board Selection

The address comparator matches the setting of the DIP switch to the address selected by the main CPU; if a match is detected, the output of the comparator triggers the logic of the PAL which issues a BOARD_SELECT and BLOCK_SELECT signals if additional conditions, I/O address and non-DMA access are satisfied. The BOARD_SELECT signal enables the data transceiver where the BLOCK_SELECT signal enables the appropriate; device for ReaD or WRite operations.

8.1.4.3.2 AIO Interface

The data is written to the 12-bit DACs in 12-bit format, and the ADC is read in 8-bit format. Two blocks of address selection are allocated to the AIO; the blocks are decoded on the AIO for individual DAC or ADC selection.

8.1.4.3.3 Pulse Counter

The pulse counter circuitry consists of six 16-bit programmable dividers, a 10 MHz crystal oscillator, and a PAL.

The 16-bit dividers are dedicated as follows:

- One divider divides the 10 MHz frequency down to 1 MHz.
- One divider is programmed to count down from a maximum pulse count, normally 10,000 pulses.
- Two dividers are utilized for a time interval measurement. One generates a time base for the second. Both dividers are clocked from the 1 MHz clock, generated by the divider described above, resulting in 1 microsecond resolution for the final count.

The Pulse Counter circuitry is programmed by the CPU for either normal operations mode mode.

Normal Mode

The normal mode is selected by setting the DIAG_MODE signal to TTL low. In this case, the PAL disables the diagnostics dividers and sets the remaining dividers for Normal Mode programming by the CPU. The system software programs the four 16-bit dividers as follows:

- 1 MHz Clock Generator: One divider that is clocked by the 10 MHz clock is programmed to divide by 10, outputting the 1 MHz clock used by the time interval counters.

- Time Base Generator: This divider is programmed to generate a time base, i.e., 1 ms, for the programmable Time counter. The counter starts counting when the ENABLE_COUNTER signal is asserted by the CPU, the counter stops when either the maximum allocated time expires or when the final count in the input pulse counter is reached.

- Programmable Time Counter: This counter starts and stops the same way as the time base generator. The counter measures the duration of an event; namely, the time duration of the maximum pulse count. The resolution of 1 microsecond is maintained by reading the internal count of the Time Base Generator at the time of the Pulse Count Termination.

- The divider clocked by the Input pulse is programmed to count down from a pre-specified number, normally 10,000, and generates an interrupt signal at the terminal count. This signal automatically stops the time counters and continues to be asserted until the CPU reads, then resets, the corresponding divider.

8.1.5 Station Controller Video Graphics Adapter

The features of the Video Graphics Adapter (VGA) include:

- Register-level compatibility with the IBM VGA Adapters
- Software-level compatibility with existing EGA/CGA/MDA and Hercules graphics standards

> NOTE
>
> The VGA board uses the same 15-pin (DB15) cable available from monitor manufacturers to interface with the IBM PS/2 computers. Using an incorrect cable may result in damage to the monitor and/or adapter.

8.1.6 Station Controller Floppy Disk

The Floppy Disk Drive is a standard PC Type 1.44 MB 3.5-inch Floppy Drive. Rotation speed is 300 RPM with an average access time of 3 mS. The drive used in the QualiTorr Remote is powered by a single 5 VDC supply.

8.1.7 Station Controller Disk Controller

The disk controller is an industry standard Floppy/IDE controller. The QualiTorr Remote Analyzer is used only on a floppy disk configured as Drive A. The other controller functions are unused.

8.1.8 Station Controller Computer Troubleshooting

Figure 8-5 shows the Station Controller computer subsystem troubleshooting procedure. To complete this test you will need a bootable floppy disk with a PC Maintenance Program installed.

PC Maintenance programs are available from your local computer store. Checkit is available from Touch Stone Software Corporation, Huntington Beach, CA.

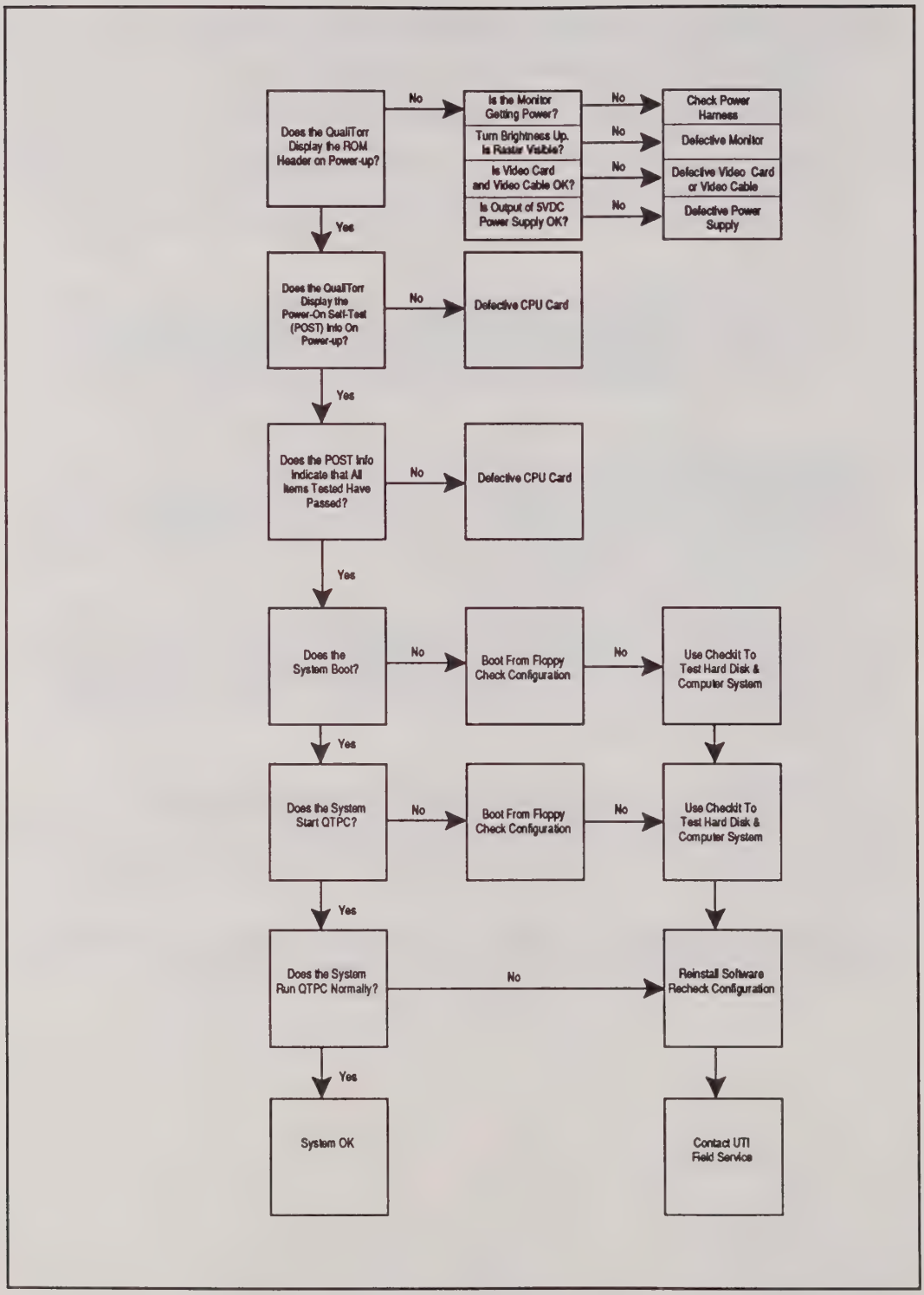


Figure 8-5. Station Controller Computer Subsystem Troubleshooting Procedure

8.2 Host Computer

The QualiTorr Remote System can be configured with either the UTI Host Computer or an OEM Host Computer.

8.2.1 UTI Host Computer

The computer system in the UTI Host Computer consists of the CPU Mother Board (with its 80386 CPU and ROM BIOS), Disk Drive Controller Board, Serial/Parallel RS-485 Board, Video Graphics Adapter (VGA) Board, Floppy Disk Drive, and Hard Disk Drive.

Computer diagnostics of the UTI Host Computer are performed without connection to the QualiTorr Remote Station (Station Probe and Station Controller). The UTI Host Computer is software configured as a standard IBM-PC compatible AT system. By booting from Floppy Drive A, industry standard diagnostic software may be run on the system.

8.2.1.1 The CMOS Setup Menu

The following screen shows the standard Setup Menu for the QualiTorr Remote UTI Host Computer (80386SX) with the 42 MB (Type 17) Hard Disk and single 1.4 MB Floppy Disk. These features are available in all versions of the BIOS. Your CMOS Setup may have more selections than those shown. Follow the on-screen instructions when performing the CMOS Setup.

```
                              AMI BIOS

DATE (MM/YY/DD)                3/28/90                          TIME
(HH:MM:SS)      8:17:31

DISKETTE 1                  1.4M
DISKETTE 2                  None
                                  CYLS.   HEADS   SECTORS          PRECOMP
 LANDZONE
DISK 1     40 Mb              17    977       5        17      300      977
DISK 2     ****Mb           None      0       0         0        0        0

VIDEO                        VGA

BASE MEMORY                  640
EXTENDED MEMORY             3072

ERROR HALT                              Halt On All Errors
SPEED SELECT                High


          DY MOVES BETWEEN ITEMS, <> SELECTS VALUES
        F10 RECORDS CHANGES, F1 EXITS, F2 FOR COLOR TOGGLE
```

8.2.2 OEM Host Computer

For OEM Host Computer maintenance, the user should isolate the Computer from the QualiTorr Remote Station (Station Probe and Station Controller) and refer to maintenance manuals describing the OEM Computer and its components. Standard diagnostic software should be run on the OEM Computer.

Chapter 9

Theory of Operation

This Chapter provides a discussion of the theory of operation of the primary components of the QualiTorr Remote System.

9.1 QualiTorr Remote System

The QualiTorr Remote System is a specially engineered form of quadrupole spectrometer. The primary components of the QualiTorr Remote System consists of the Station Probe, Station Controller, and the Host Computer. The Station Probe and Station Controller provide a single QualiTorr Remote Station. Each Remote Station provides one channel of process gas analysis.

One to eight QualiTorr Remote Stations can be controlled and monitored from a single Host Computer by the use of RS-485 communications. Multiple Remote Stations are connected via multi-drop RS-485 cables and Remote Station #1 is connected to the Host Computer by a single RS-485 null modem cable.

The relationships of Station Probes, Station Controllers, and the Host Computer is summarized in Figure 1-1. Figure 4-10 shows a Single Probe QualiTorr Remote System. Figure 4-11 shows a Multiple Probe QualiTorr Remote System with the UTI Host Computer. Figure 4-12 shows a Multiple Probe QualiTorr Remote System with an OEM Host Computer.

9.2 QualiTorr Remote Station

A single QualiTorr Remote Station consists of a single Station Probe and a single Station Controller. The block diagram in Figure 9-1 shows the Probe with its Ionizer, Mass Filter, and Ion Multiplier attached to the User's Process. The RF Module provides RF Power, RF Control, and a Picoampmeter for the Probe. This module is connected to the Mass Spectrometer Subsystem. Analog signals from the Mass Spectrometer Subsystem are processed by the Analog/Digital I/O Board and the CPU board. Communications with the Host Computer and other QualiTorr Remote Stations is handled by the RS-485 Serial I/O Card. Connection to the Host Computer is via a Null Modem RS-485 Cable and connection to other Remote Stations is via multi-drop RS-485 Cables.

Maintenance on a QualiTorr Remote Station is conducted by connecting a VGA Monitor and AT Keyboard to the Station Controller and operating the Remote Station in Local Mode (Maintenance Mode). See Chapter 8, Computer Maintenance, for additional information.

Figure 9-2 shows the QualiTorr Remote Station Subsystem Interaction Diagram. The diagram shows the interaction of subsystems of the Station Controller (RT Controller) and Station Probe (RF and Probe). The figure shows the interaction of the Ionizer, Rods, and Electron Multiplier (Mult) in the probe, the RF Control Board, Signal Processor Card, and the RF Power Board in the RF Module, and the Computer System, Computer Power Supply, Power Transformer, Rectifier Mother Board, Multi-voltage Power Supply, Filament Supply Board, DC Rod Amplifiers (DC Rod Amps), Multiplier High Voltage Board (Mult HV Card), Control Board, and Ionizer Board in the Station Controller.

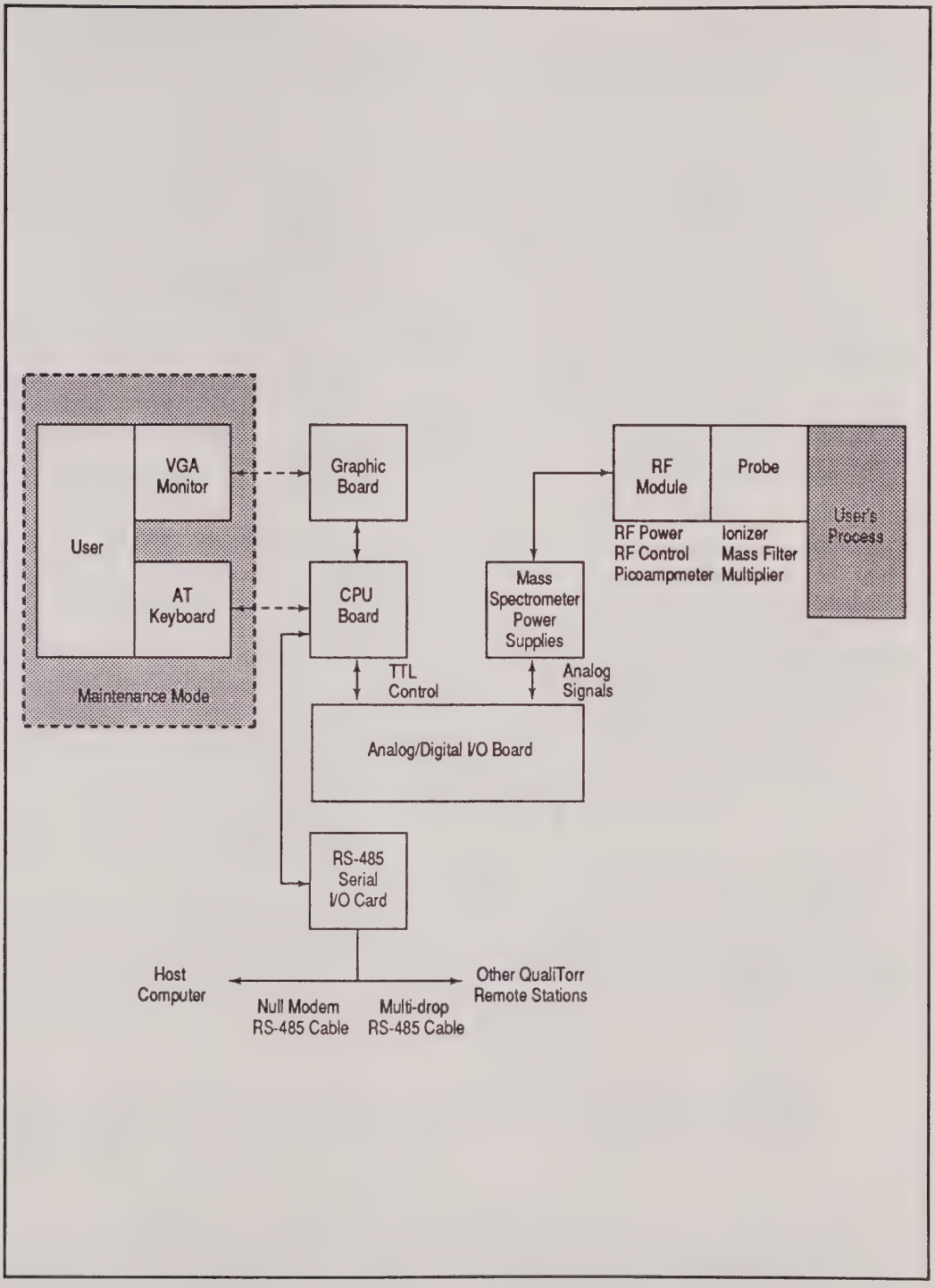


Figure 9-1. QualiTorr Remote Station Block Diagram

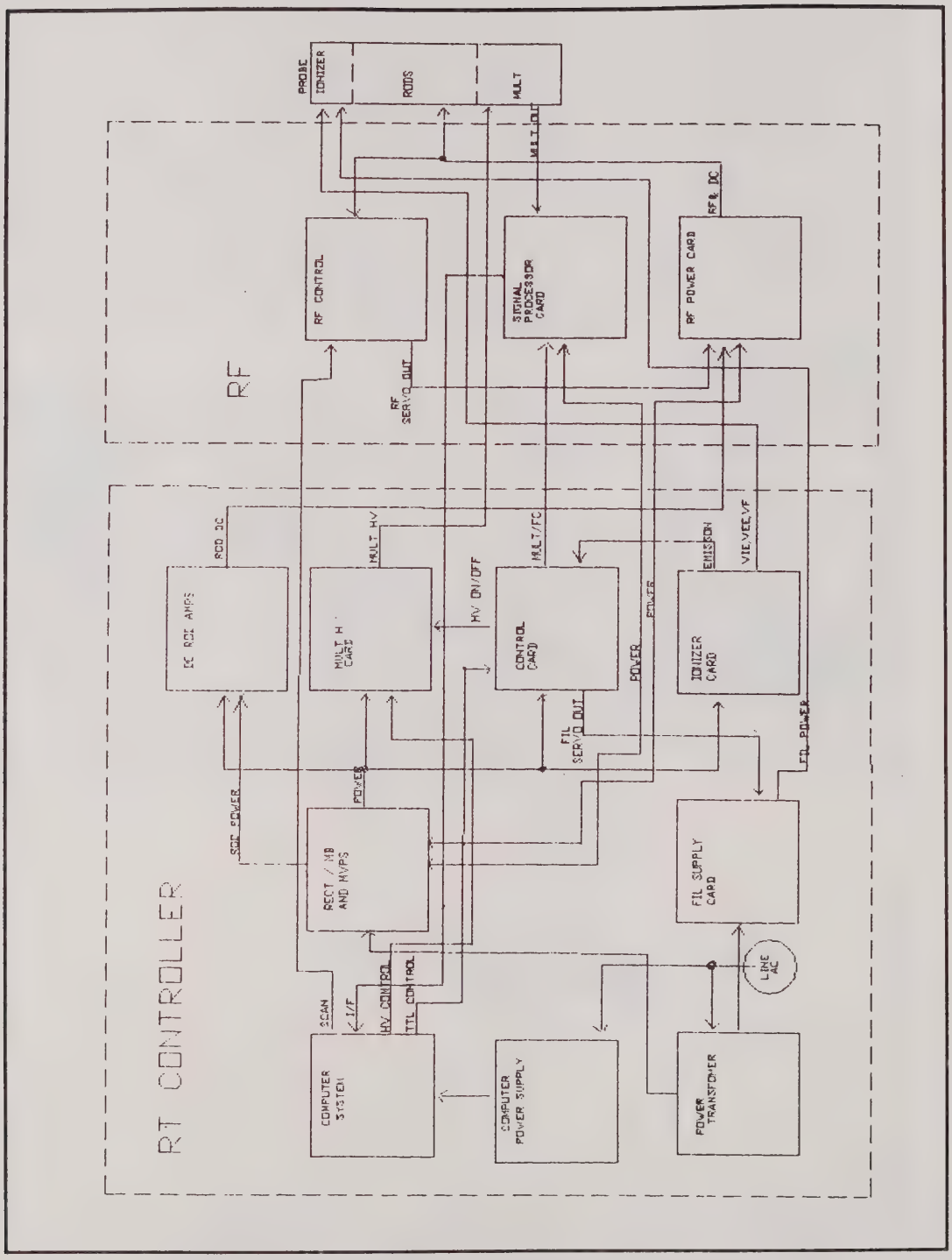


Figure 9-2. QualiTorr Remote Station Interaction Diagram

9.2.1 Station Probe

The Station Probe consists of an RF Module, a Probe, and a Sampling System. All power for the Station Probe is provided by the Station Controller.

9.2.1.1. RF Generator

During a scan, the RF generator provides from 0 to 1500 VAC at 1.6 MHz to the rods to oscillate the ions that are caught in the quadrupole field. The quadrupole uses a combination of high frequency and DC voltages to allow only the desired mass/charge ratio (m/e) valued ions to pass through it. A positive ion entering one end of the combined field geometry, provided by the DC voltage and the RF on the rods, must undergo stable oscillations in both the x and y directions to be detected. With all other parameters maintained constant, this stability is dependent upon the ion's mass to charge ratio. Other ions with different mass-to-charge ratios are swept out of the electric field, are collected by the rods, and are not detected. The ions are essentially "identified" by their ability to remain stable or unstable in the RF and DC environment through which they pass. The RF and DC amplitude controls the mass-to-charge ratio of the ions that are allowed to pass through the filter at any given time. This same voltage is controlled by the DAC in the computer system.

9.2.1.2 Probe and Sampling System

The UTI family of probes and samplers accommodates the need for a versatile instrument that will meet the needs of a wide range of applications and process pressure domains. The Probes available are the Open Ion Source (used with or without a sampler), the Closed Ion Source (used only with a sampler), and the Fast Response Probe (used with the FRSM sampler). The sampling modules allow the QualiTorr Remote to monitor processes over a wide range of pressures from 1520 to 10^{-4} Torr. The samplers are designated by the acronyms: 1PSM, 2PSM, 3PSM, 4PSM, APSM, and FRSM. Details of the samplers' specifications are provided in Chapter 1. A discussion of the pressure-reduction orifices used by the samplers appears in Appendix B.

9.2.2 Station Controller

The Station Controller shown in Figure 1-2 houses the power supplies and amplifiers necessary to drive one Station Probe and to collect one channel of process gas analysis data. The computer system in the QualiTorr Remote Station Controller consists of an IBM PC AT-compatible 80286 Mother Board, 1.4 MB Floppy Disk, and associated control boards and power supplies. The Station Controller can be run in Host Computer Mode or in one of two maintenance Modes–Local Mode and PC Mode. See Chapter 8, *Computer Maintenance*.

The Station Controller runs in Local (Maintenance) Mode operation when it is disconnected from the Host Computer and booted with the floppy diskette labeled "QualiTorr Remote - Local QualiTorr III Simulation." Local Mode operating instructions are provided in Appendix D.

The Station Controller runs in Host Computer Mode when it is connected to the Host Computer and booted with a Station Probe-specific floppy diskette. In this mode, all Remote System monitoring and control is available to the user via the Host Computer. In UTI Host Mode operation, each Station Controller must have its Station Probe-specific floppy diskette software running. For example, the Station Controller for Remote Station #1 must be running the floppy diskette labeled "QualiTorr Remote System Disk Station #1."

The Station Controller contains the CPU Mother Board, Rectifier Mother Board, MVPS Board, Floppy Disk Drive, Computer Power Supply, and Filament Supply. The Mother Board supports the Analog/Digital I/O Board, Disk Drive Controller Board, Serial Parallel Board (RS-485) and the VGA Display Board. The Rectifier Mother Board supports the Multiplexer (High Voltage Board), Control Board, Ionizer Board, and the Rod Driver Board. The locations of all of the boards are shown in Figure 5-7. Figures 9-1 and 9-2 show the inter-relationships of the functional components of the QualiTorr Remote Station.

9.3 Host Computer

One to eight Station Controllers can be operated by a single stand-alone Host computer. The UTI Host Computer with the UTI Host Computer software to provide the standard UTI operating configuration. Alternatively, a different computer can be used to provide an OEM Host Computer operating configuration. OEM Host Computer operation requires that the customer provide suitable software.

9.3.1 UTI Host Computer

Figure 4-10 shows a single probe Remote System with a UTI Host Computer. Figure 4-11 shows a multiple probe Remote System with a UTI Host Computer.

The UTI standard operating configuration uses a 33 MHz 80386 computer with a 40 MB hard drive, 4 MB RAM, 1.44 MB 3.5-inch floppy drive, 14-inch VGA monitor, and keyboard. UTI QualiTorr Remote software runs on the UTI Host Computer under the Disk Operating System (DOS) to provide the user-friendly, simple-to-understand menus that guide the user in a logical and efficient manner through all procedures and analyses. Process mass spectra are analyzed and displayed in simple to read color-coded charts and graphs.

The UTI Host Computer Software is pre-loaded onto the Host's Hard Disk and a QualiTorr Remote System Disk is required in each of the Station Controllers that is on the network. In UTI Host Mode operation, each Station Controller must have its Station Probe-specific floppy diskette software running. For example, the Station Controller for Remote Station #1 must be running the floppy diskette labeled "QualiTorr Remote System Disk Station #1."

The Host Computer's master menu for a four-station QualiTorr Remote System is shown in Figure 1-3. The pull-down menus are shown fully extended to simultaneously display the functions available under the *System* Menu and each of the Station *Menus*.

9.3.2 OEM Host Computer

Figure 4-12 shows a multiple probe Remote System with an OEM Host Computer. The OEM Host Computer System allows the user to monitor and control multiple Remote Stations using a computer other than the UTI Host Computer. Contact your UTI representative for additional information concerning QualiTorr Remote OEM Host Computer Systems.

9.4 Station Controller Computer Subsystem

The Station Controller's Computer System consists of the CPU Board, CPU ROM BIOS, Analog/Digital I/O Card, Serial/Parallel RS-485 I/O Card, VGA Display Board, Floppy Disk Drive Controller Board, and Floppy Disk.

9.4.1 CPU Card

The CPU Card in the Station Controller is a standard IBM PC/AT-compatible 80286 computer Mother Board. The CPU Mother Board has 1 Megabyte of Random Access Memory (RAM).

9.4.2 Analog/Digital I/O Card

The Digital/Analog Input/Out (A/D I/O) Card combines Digital and Analog processing on a single board and links the QualiTorr electronics to the Central Processing Unit (CPU). See Figure 9-1.

In addition, a 10 MHz opto-isolated pulse counter circuit are implemented on the DIO. The pulse counter performs the function of counting input pulses up to a pre-programmed maximum time period or count.

Two 8-bit opto-isolated input ports and one 8-bit opto-isolated output port are utilized for Analog Electronics Interface. Each input port bit consists of a series resistor, and opto-isolator, a pull-up resistor, and TTL tri-state buffer (1/8 of a 74LS244) connecting it to the local data bus. Each output bit consists of a latch (1/8 of a 74LS374), a series resistor, and an opto-isolator. In addition, one 8-bit opto-isolated input port and one 8-bit opto-isolated output port are available for future expansion.

The data is written to the 12-bit DACs in 12-bit format, and the ADC is read in 8-bit format. Two blocks of address selection are allocated to the AIO; the blocks are decoded on the AIO for individual DAC or ADC selection.

Dip Switches

The address comparator matches the setting of the DIP switch to the address selected by the main CPU; if a match is detected, the output of the comparator triggers the logic of the PAL which issues a BOARD_SELECT and BLOCK_SELECT signals if additional conditions, I/O address and non-DMA access, are satisfied. The BOARD_SELECT signal enables the data transceiver where the BLOCK_SELECT signal enables the appropriate device for ReaD or WRite operations.

9.4.3 Serial/Parallel RS-485 I/O Board

The Serial/Parallel RS-485 Board provides serial, parallel, and RS-485 data communication ports for the Station Controller.

9.4.4 VGA Display Board

The VGA Display Board provides the following functions and features:

- Register-level compatibility with the IBM VGA
- Software-level compatibility with existing EGA/CGA/MDA and Hercules graphics standards
- Graphics Resolution Mode (640 x 480 pixels)

9.4.5 Floppy Disk Drive Controller Board

The Disk Controller is an industry standard 2 floppy/2 IDE card designed for the IBM PC/AT-compatible Bus.

9.4.6 Floppy Disk

The QualiTorr Remote Station Controller uses one 3.5-inch built-in removable floppy disk with 1.4 Mbytes of storage capacity.

9.4.7 Auto-Ranging

References: Figures 9-3

The QualiTorr Remote's signal processor and control cards provide Auto-Ranging between two electrometer ranges to achieve eight decades of dynamic range. The Auto-Ranging circuit is shown in Figure 9-3. The electrometer feedback is switched between a 1 Meg ohm resistor (R26) and a 100 Meg ohm resistor (R3). The 100 Meg ohm resistor (10^{-8} range) is used for the signals below 10^{-6} and the 1 Meg ohm resistor (10^{-6} range) is used for signals above 10^{-6}.

A comparator (U3) on the output of the electrometer switches a relay (K3) via a latch (U2) on the Control Board. The relay selects the gain of the electrometer. If the electrometer is in high gain (10^{-8}) and the comparator input voltage goes over 7.5 V, the comparator outputs an over-range signal. This signal is an input to the "Range OK" latch (U2) on the control card. The latch waits for a range change pulse from the computer system. When this pulse triggers the latch the relay is switched to the 10^{-6} range.

Hysteresis is added via a relay (K5) that switches the voltage reference on the comparator. The low gain (10^{-6}) range is held until the signal falls below 15 mV. At 2 MV the comparator turns the over-range signal off. Then the latch switches the relay back to the high gain (10^{-8}) range after the range pulse trigger.

The range change pulse triggers the "Range OK" latch after stepping the RF and before the pulse count. This synchronizes the ranging and the data acquisition. The output of the latch also sets the range flags. The range flags are read by the computer. The computer rescales the data according to the range flag state. This process is transparent to the user.

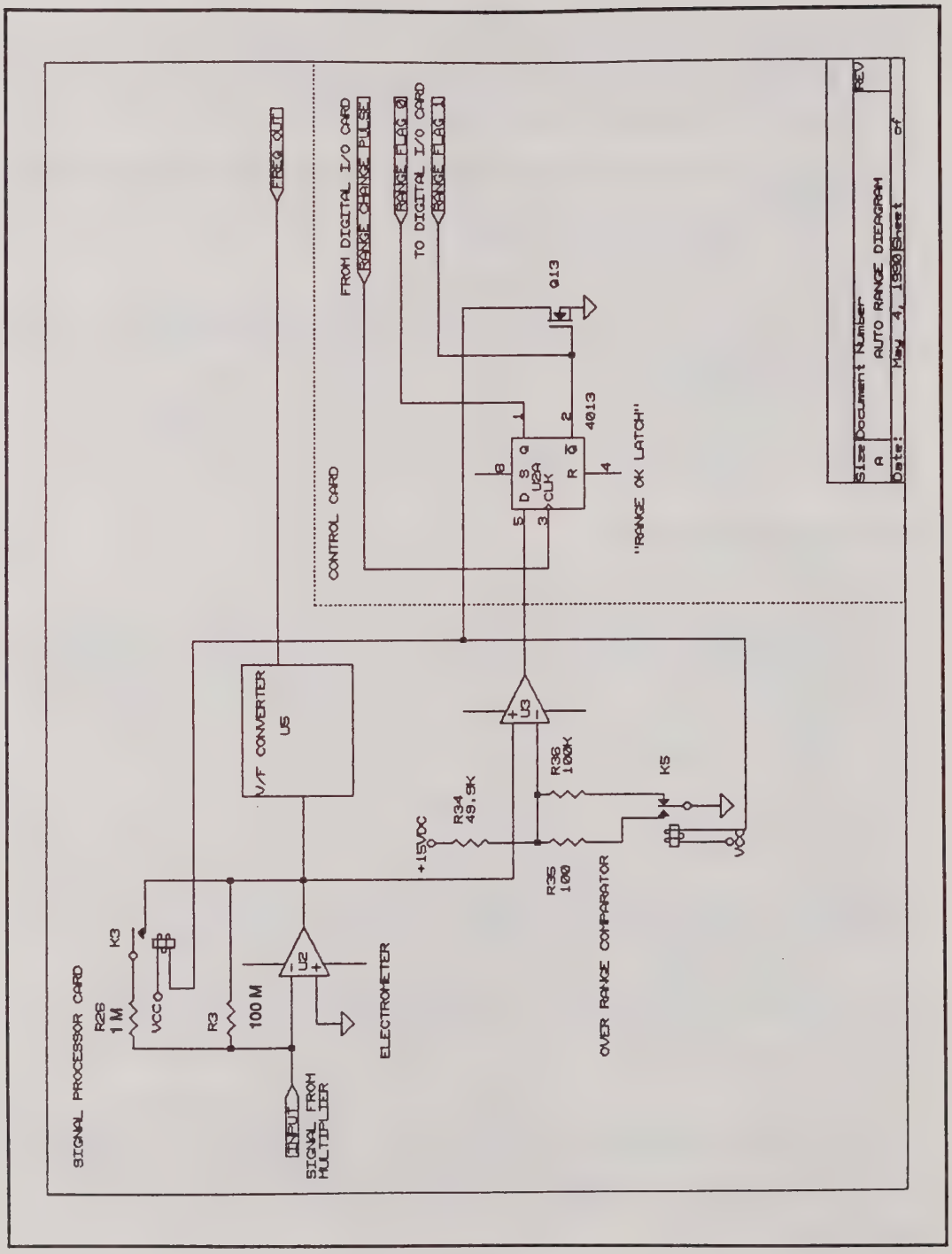


Figure 9-3. Auto-Ranging Circuit

9.5 Analog Mass Spectrometer Subsystem

The QualiTorr Remote analog mass spectrometer consists of the Probe, the Ionizer Subsystem, the Quadrupole Mass Filter Subsystem, the Electron Multiplier Subsystem, and the Basic Power Supplies.

9.5.1 The Probe

The Probe consists of the Ionizer, Mass Filter, and Ion Detector.

9.5.1.1 Ionizer

As explained throughout this manual, the QualiTorr Remote probe is available with two types of ionizers: closed and open. The closed ion source is used for applications that have elevated pressures that require trace detectability of background gases. The open ion source is used for applications that have low system pressures that require detectability of system gases.

9.5.1.1.1 Closed Ion Source

Reference: Figure 9-4

Some of the major design characteristics of the patented (U. S. Patent Numbers 4,689,574 and 4,579,144) closed ion source include:

1. A small enclosed grid volume contains the sampled gas molecules and/or atoms to be analyzed. This central part of the ionizer, kept at the appropriate source pressure, allows preferential ionization of the inletted gas. This design keeps the gases characteristic of the background of the probe chamber and pump region several orders of magnitude removed in intensity.

2. Dual filaments operate simultaneously opposite two strategically located small holes in the solid grid structure. These filaments operate in the external region of the grid volume and in the ultra-high vacuum portion of the probe chamber. The filaments, usually tungsten, present minimal opportunity for chemical or thermal interaction with the sampled gases. The filament to grid current (emission) is kept at approximately 0.3 milliamperes.

3. Gas in the grid volume is ionized by energetic electrons, nominally 70 eV, that are drawn from the filaments towards the grid and through the two grid apertures. Ions of all gas species are drawn toward the focus plate, are focused, and are injected into the quadrupole filter region. The potential of the grid above ground establishes the ion energy. This is kept at approximately 2 volts.

As delivered from the factory, all closed source ionizer voltages are optimized and specified approximately as follows: Ion Energy +2 VDC, Electron Energy -68 (±2) VDC, and Focus Voltage -20 (±10) VDC (Focus Voltage may vary from this value for some instruments). These are considered calibrated values, since they all affect the instrument's basic sensitivity. The specified voltages are referenced to ground. The total electron energy is represented by the absolute value of VIE plus VEE. The emission current is the electron current from filament to grid and is precisely regulated. It is measured on the Ionizer Board and adjusted on the Control Board.

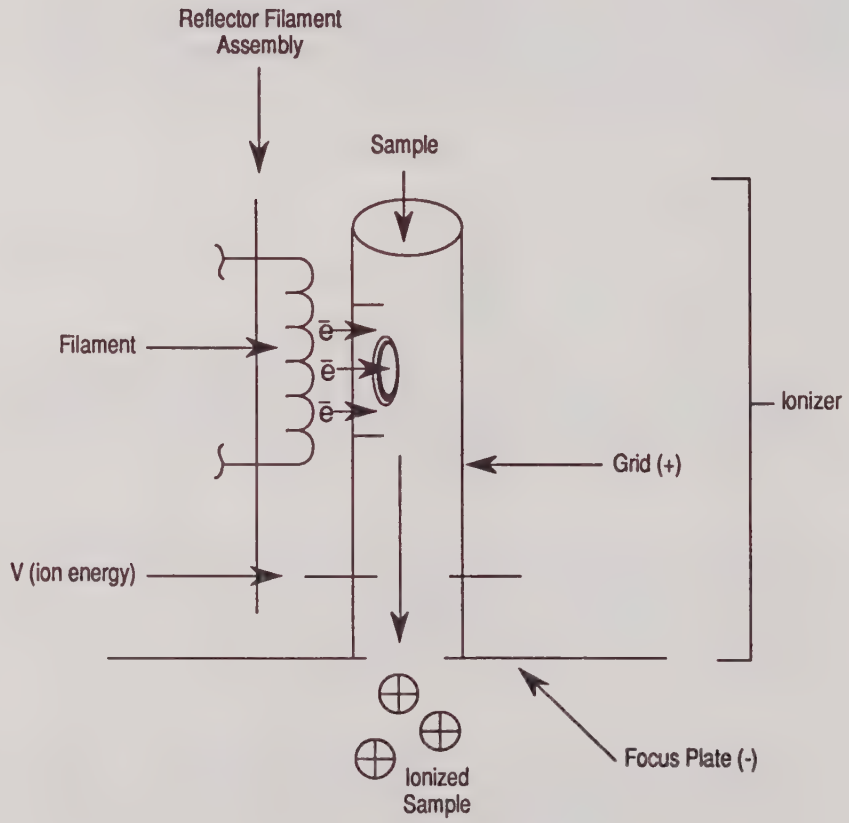


Figure 9-4. Closed Ion Source

9.5.1.1.2 Open Ion Source

Reference: Figure 9-5

Some of the major design characteristics of the open ion source include:

1. Dual filaments operating simultaneously with automatic, constant, emission control in the event of failure of either filament

2. Ultra-long path length of ionizing electrons via multiple passes through the cylindrical grid region

3. Gridded, 2 π stearadian open design to permit normal RGA work and cross or axial beam operation.

Thermionically emitted electrons from dual hot filaments are accelerated toward the grid, which is at positive potential with reference to the filaments and ground. Electrons which do not strike a grid wire or do not ionize any substance, pass through the grid volume into the region between grid and reflector. There they decelerate and re-accelerate back toward the grid because of the electric field produced by the negative reflector voltage and positive grid or are lost by recapture. Many electrons go from the ionizing region to surrounding ground surfaces.

If sufficient energy is transferred through electron interaction with neutral atoms or molecules in the ionizer, a positive ion is formed. Within the grid volume, ions are attracted toward the center by the negative potential produced by the increasing electron density toward the center. The ions are also drawn toward the focus plate which is kept at a negative potential to provide initial extraction and some focusing of the ions into the filter section.

The average electron energy is produced by the voltage difference (typically 70 VDC) between filament (and reflector) and grid. The grid is operated at a variable potential (0 to +24 VDC) above ground which establishes the ion energy.

As delivered from the factory, all open source ionizer voltages are optimized and specified approximately as follows: Ion Energy +15 (±5) VDC, Electron Energy -55 (±5) VDC, Focus Voltage -20 (±10) VDC, (Focus Voltage may vary from this value for some instruments). The **total** electron energy is represented by the absolute value of VIE plus VEE. These are considered calibrated values, since they all affect the instrument's basic sensitivity. All voltages are referenced to ground, and since they are optimized, may vary from instrument to instrument.

The emission of electrons is limited by the maximum current allowed through the filaments. On all UTI instruments with any type of filament, this is clamped at 6 Amps. The emission current is the electron current from filament to grid which is precisely regulated. It is measured on the Ionizer Board (TP2 referenced to TP7, and, see Figure 6-2) and adjusted to 2.0 (± 0.8) mA (2 (± 0.8) volts on the volt meter) on the Control Board, R39. See Figure 6-3.

The ionizer operates similarly to a Bayard-Alpert ionization gauge except that no central wire exists to collect the positive ions. Instead, the ions are extracted from the ionizer into the quadrupole rod structure where filtering occurs (for a brief discussion of filtering see Section 9.2.1.1).

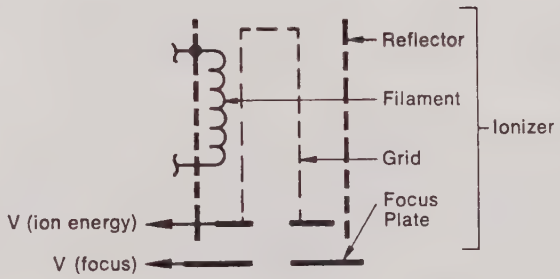


Figure 9-5. Open Ion Source

9.5.1.1.3 Filaments for both Closed and Open Ion Sources

Both filaments operate simultaneously under normal operation. If a single filament opens during operation, the control circuit automatically readjusts the emission from the single remaining filament to the value set at the console. The FILAMENT light is also turned on automatically to indicate that only a single filament is operational. (Note that the sensitivity of the closed source will drop by a factor of two with a single filament; the open source sensitivity will not change.) If either one or both of the filaments are open, the FILAMENT light will be On. If the FILAMENT light *flashes*, the filament protect circuit has tripped and the filaments have thus been forced off.

The ionizer is constructed of type 304 stainless steel, alumina ceramic and tungsten/3% rhenium filaments. Replacement of filaments is a simple operation, but must be done with care. The ionizer is well suited to applications in the high to ultra-high vacuum range (10^{-3} to 10^{-14} Torr). At pressures above 1×10^{-5} Torr, one should expect normal non-linearities to appear that are attributable to collisional effects, and potential distortions. These effects can be minimized by operation at reduced emission current settings.

For an emission range of 0.5 to 5.0 mA, UTI ionizer filaments (Open Ionizer Source) exhibit the following ranges for temperature and power consumption.

Table 9-1 summarizes the emissivity characteristics for three types of filaments that are available for the QualiTorr Remote.

Table 9-1. Filament Emissivity Characteristics

Material	Temperature Range (°C)	Power Range (watts)
ThO_2/Ir	1300-1500	6 - 8
W/3%Re	1600-2100	13 - 25
Re	1750-2050	9 - 25

Table 9-2 shows the chemical properties and characteristics for three types of filaments.

Table 9-2. Filament Chemical Properties

Property	ThO_2/Ir	W/3% Re	Re
CO production	unknown	high	high
CO_2 production	high	mod.	mod.
O_2 consumption	low	high	high *
H-C consumption	unknown	high	low
water entrapment	maybe high	low	low
volatility in O_2	low	high	v. high **

* Loss of one filament caused the O_2/N_2 ratio to increase 17.6%.

** Exposure to air at 10^{-6} Torr caused failures of the filament pair at 30 and 95 hours.

9.5.1.2 Mass Filter

Reference: Figure 9-6

A combined radio-frequency and electrostatic field is formed by two pairs of metal rods in the mass filter section. A charged gas atom or molecule with a specific mass-to-charge ratio will have a dynamically stable trajectory within the field formed by the voltages on the rods; all other ions will be filtered out. By continuously varying the applied voltages, a range of substances can be sequentially stabilized, and these transverse the length of the filter assembly.

The filter section consists of four precisely machined 3/8-inch stainless steel rods which are accurately aligned and attached to alumina insulators. This structure is enclosed in a stainless steel cylinder. The ionizer attaches to one end and the ion detector to the other. Fringe field distortions at entrance and exit electrodes produce less distortion in ion beam trajectories with the use of large rod diameter and ion beam area. High absolute transmission efficiency of ions emerging from the filter as well as a higher relative transmission of high-to-low mass substances are achieved with the UTI precise rod structure.

The RF and DC voltages applied to the rods produce the dynamic field necessary for mass filtering. The DAC on the Analog I/O Board produces the signal to scan the RF voltage continuously from about 0 to 1500V RMS. This scans the entire mass range. The RF frequency is 1.6 Mhz.

The ±DC Rod Amplifier circuits produces a positive and negative DC voltage in some fixed ratio to the RF voltage. The location and spacing of the peaks is determined by the magnitude of the RF and DC voltages, whereas the DC/RF ratio determines the resolution of one mass peak from another.

The filter rod assembly should not be disassembled for cleaning or inspection. If, for any reason disassembly is required, return the mass filter rod assembly to the factory.

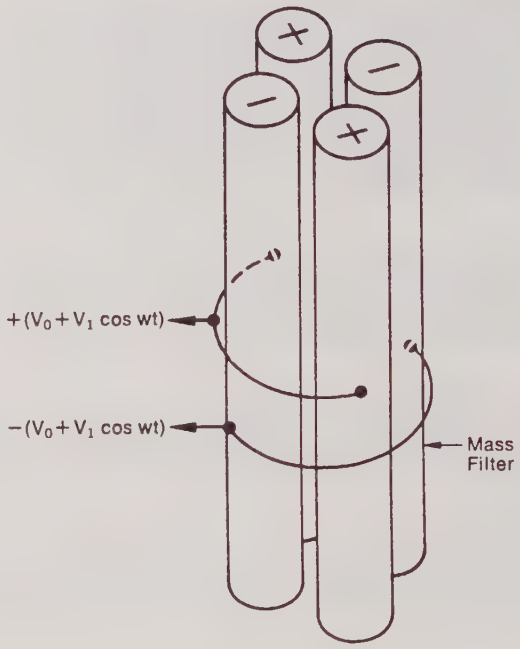


Figure 9-6. Mass Filter

9.5.1.3 The Ion Detector

Reference: Figure 9-7

Once the selected ions exit the mass filter, they need to be detected and quantitatively measured. The Electron Multiplier is the ion detector that is presently used in the QualiTorr Remote. A Faraday Cup (FC) or continuous dynode detector is provided in the standard QualiTorr Remote model.

9.5.1.3.1 UTI CuBe Electron Multiplier

The substances traversing the filter are detected by an "electron multiplier" which amplifies the single charge of the ion into a current. The output current of the multiplier (and amplifier) is referenced against the scan voltage, thereby producing a spectrum of peaks. The spectrum produced shows ion current as a function of the quotient mass/charge in a series of peaks corresponding to different ions. The amplitude represents the quantity of each type of ion. Discrete peaks occur because the charged substances have discrete masses and discrete charges (usually single).

The basic component of the ion detector is a 16-stage electron multiplier shown in Figure 9-7. Each stage is a Cu/Be oxygen activated dynode with a potential difference of approximately 60 to 200 Volts between each stage. Ions emerging from the filter section are drawn toward the first dynode which is kept between -1 kV and -3 kV during operation. The implanting ions cause emission of secondary electrons which are then attracted toward the second dynode, and so on down the chain to the anode. Each electron striking a dynode releases between one and two electrons on the average, thus producing a charge multiplication on the order of 10^4 to 10^6, depending upon the age and condition of the multiplier, as well as the high voltage value used.

The first dynode is outside the line-of-sight of the filter section and cannot receive spurious signals from soft X-rays produced in the filter, and photons produced in the ionizer. This feature, together with a very efficient source, a high transmission filter, extends the detection capability of the instrument to the 10^{-11} Torr partial pressure range.

The electron multiplier gain starts out at about 3×10^5 for N_2, typically at a voltage of approximately 2000 VDC. As time passes, it is necessary to increase the multiplier voltage to maintain the desired instrument sensitivity. While the gain of a fresh multiplier may exceed 10^7 at 3000 VDC, UTI prefers to base specifications on performance which is usable for extended periods of time. The noise (dark current from the anode) is less than 2×10^{-12} amps, at a gain of 10^5. The output of the CuBe multiplier is linear to 10 microamps.

9.5.1.3.2 Continuous Dynode Multiplier

The continuous dynode ion detector, shown in Figure 9-7A, is provided as an option for the "long" sensing probes offered by UTI.

The short probes all contain the continuous dynode multiplier shown in Figure 9-7B. This type of multiplier is used where the types of gases studied or the operating environment is particularly deleterious.

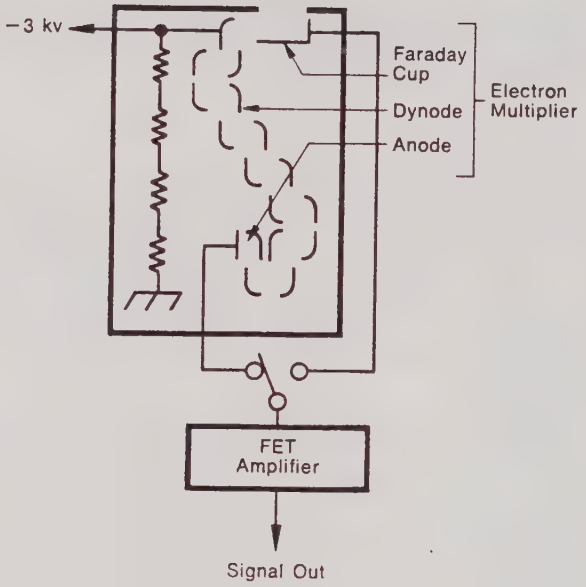


Figure 9-7. UTI CuBe Electron Multiplier

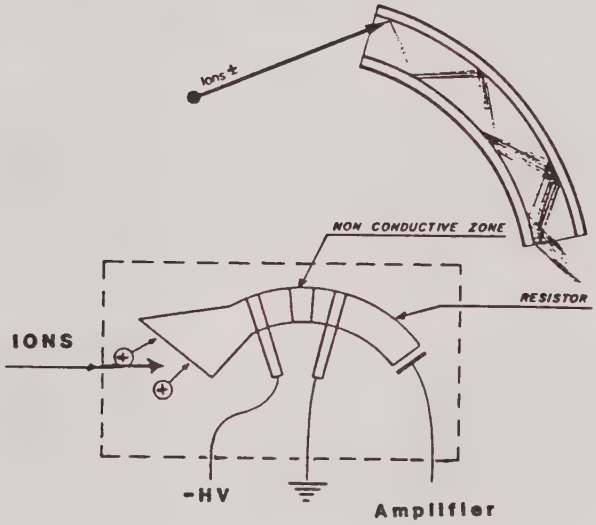


Figure 9-7A. Continuous Dynode Multiplier (Long Probe)

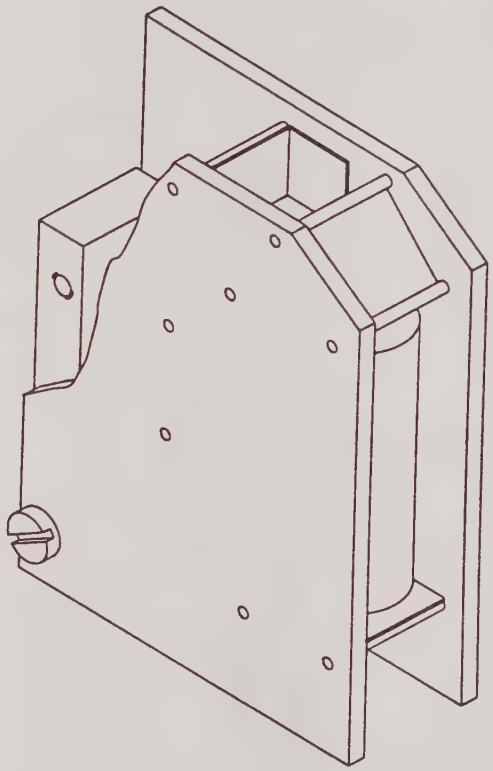


Figure 9-7B. Continuous Dynode Multiplier (Short Probe)

9.5.2 Ionizer Subsystem

The Ionizer Subsystem consists of the VIE Supply, VF Supply, VEE Supply, Filament Power Supply, Emission Control, and Filament Protect circuits.

9.5.2.1 VIE Supply

The Voltage Ion Energy (VIE) Supply provides bias voltage to the filaments of the ionizer. The supply can be adjusted from 0 to 24 VDC, but should measure approximately 15 VDC for an open source and 2 VDC for a closed source.

9.5.2.2 VF Supply

The Voltage Focus (VF) Supply provides voltage to the focus plate, referenced to ground. The total range of the supply is 0 to 100 VDC. A typical voltage of 20 VDC should provide optimum sensitivity at both low and high mass values.

9.5.2.3 VEE Supply

The Voltage Electron Energy (VEE) Supply provides a voltage to energize electrons between the ionizer reflector and the grid. The total voltage range of this supply is 0 to 100 VDC. The VEE Supply tracks the VIE supply voltage. The voltage measured to ground is 55 VDC for an open source and 68 VDC for a closed source and is always 70 VDC measured to VIE.

9.5.2.4 Filament Power Supply

The Filament Power Supply provides up to 6 VDC, 6A, to heat the filaments used for emission. The typical output voltage across the filaments is 4 VDC. The filament resistance is typically 0.2 (two filaments) to 0.5 (one filament) ohm if the filaments are cold and 0.3 (two filaments) to 0.6 (one filament) ohm if the filaments are hot. The typical current drawn is 4.0 A when the filaments are cold and 4.5 A when they are hot.

9.5.2.5 Emission Control

The Emission Control circuitry is on the Control Card and provides a closed-loop circuit that regulates emission and controls the filament power supply. The emission tracks the voltage set by the emission potentiometer on the Control Board.

9.5.2.6 Filament Protect

The over-pressure protection provided in the QualiTorr Remote will turn off the filament current when the pressure in the probe/ionizer region reaches the mid 10^{-3} Torr region. The **Remote** Status function in each Station menu will indicate when the protect circuit has tripped. This circuit operates by sensing a change in the filament power due to cooling from excessive pressure. Filament power varies from ionizer to ionizer, but runs typically at 4 to 4.5 Amps (ThO_2-Ir ≈ 3 Amps), and trips the protect circuit at 6 Amps. If the user wishes to vary the ionizer voltages from their factory preset values, it may be necessary to switch out the over-pressure protection and readjust. See Chapter 6, Figure 6-4 (SW1).

9.5.3 Quadrupole Mass Filter Subsystem

The Quadrupole Mass Filter Subsystem consists of the RF Power Supply, the RF Detector, RF Servo Control, DC Rod Power Supplies (+ and -), and the circuitry for the Total Pressure Mode.

9.5.3.1 RF Power Supply

The RF Power Supply is a 3.2 MHz crystal oscillator for precise frequency control. This oscillator output is divided in two and phase split to drive a push-pull output stage at 1.6 MHz. The output stage drives a series resonating tank made of a toroidal inductor and the rod capacitance in the probe. This tank has a Q of 100, so 10 VAC input will result in 1000 VAC across the probe when the tank is tuned to resonance.

9.5.3.2 RF Detector

The RF Detector is fed from a tap off the tank. It is a high speed precision rectifier using Schottky detector diodes that are linearized by a very high speed operational amplifier. The detector outputs two out of phase half-wave signals. These two signals are fed into the two sides of a differential amplifier integrator. The output of this differential amplifier is a clean precise signal representing the envelope of the RF being sent out to the rods. This envelope is used by the (+) and (-) rod amplifiers and the RF control servo.

9.5.3.3 RF Servo Control

The RF output to the rods is precisely servo controlled for mass location stability. The RF detector envelope is compared to the scan drive. Any error is used to control the RF power output. The transfer function for loop control is 25 millivolts scan DAC output per AMU.

9.5.3.4 DC Rod Power Supplies (+ and -)

The DC Rod Power Supplies provide the ± Rod voltages of about 0.5 VDC/AMU, when adjusted at typical operating resolution.

9.5.3.5 Total Pressure Mode

The Total Pressure mode turns off the mass filter so that all of the ions can be accelerated into the electron multiplier when the system pressure is measured. In the Selected Peak Monitoring SPM mode (Local Mode) or Dynamic Mode (Host Computer Mode), the total pressure read this way is calibrated if the process system pressure is properly entered in the initial startup/calibration procedure. (See Section 4.5.3.) In the Static Scan mode, individual partial pressure peaks are summed to provide a total pressure value.

9.5.4 Electron Multiplier Subsystem

The electron multiplier subsystem consists of the Electron Multiplier Power Supply, Faraday Cup, Picoammeter, and Voltage to Frequency Converter.

9.5.4.1 Electron Multiplier Power Supply

The Electron Multiplier Power Supply provides 0 to 3000 VDC to the electron multiplier. This voltage can be selected from the Console by keying in the desired voltage manually using the Set Multiplier Voltage function of the Utilities Menu. The electron multiplier voltage is normally set by the computer system during calibration of the instrument.

9.5.4.2 Faraday Cup

The Faraday Cup (FC) is literally a metal cup that neutralizes an ion when it enters and strikes the cup by giving up a single electron. An ammeter is connected to the cup to measure the current of electrons required to neutralize the incident ions. This detector is functional on the QualiTorr Remote, but is used only during maintenance to check the basic sensitivity of the probe. (See pages 6-6 and 6-10.) To use the QualiTorr Remote in the Faraday Cup mode of operation, the Faraday Cup jumper (J17) on the Control Board (see Figure 6-3) must be On (two pins shorted together).

9.5.4.3 Picoammeter

A picoammeter (electrometer), employing a FET input operational amplifier for amplifying and measuring currents, is an integral part of the analyzer and is located in the RF generator. It is used to measure and amplify ion currents from the electron multiplier anode on the order of 10^{-7} Amps, direct reading. The correlation is 1.0 microampere = 10 VDC output.

9.5.4.4 Voltage to Frequency Converter

The Voltage to Frequency Converter circuitry provides a six-decade dynamic range: 10 V = 10 MHz, 1 V = 1 MHz, 0.1 V = 100 kHz, 0.01 V = 10 kHz, 0.001 V = 1 kHz, 0.0001 V = 100 Hz.

9.5.5 Basic Power Supplies

9.5.5.1 +32 VDC

This power supply provides voltage to the RF Power Amplifier.

9.5.5.2 ±18 VDC

This power supply provides voltage to the RF Generator for the analog circuits. It is regulated to ±15 VDC in the RF Generator.

9.5.5.3 ±15 VDC

This power supply provides voltage for the analog circuits in the Control Console.

9.5.5.4 ±12 VDC

This power supply provides voltage for the RS-232 interface on the CPU Card and +12 VDC for the disk drives.

9.5.5.5 +5 VDC

This supply powers the Digital I/O Card, CPU Card, Analog I/O Card, and the Video Graphics Adapter Card.

9.5.6 Leak Hunter (Optional)

The compact, hand-held leak detector is available as an option for use with the QualiTorr Remote Station Controller. A light bar and variable pitch audio signal are activated when a leak is detected. Threshold values are set on the leak detector to adjust for changing background levels. The hand-held Leak Hunter is shown in Figure 6-17.

The Leak Hunter consists of the following circuits: Input Amplifier/Buffer, Manual Threshold Reference, Automatic Threshold Reference, Audio Bias/Clamp/Filter/Inversion Stage, VCO, Audio Amplifier, and LED Bar Graph Display.

9.5.6.1 Input Amplifier/Buffer

This stage consists of a differential amplifier that only passes input signals greater than the threshold reference voltage. Values less than the reference voltage cannot be passed since the whole circuit is running off a single polarity supply and negative voltages cannot be obtained. The source of the threshold reference voltage is fed to the non-inverting input by S2.

There are two gains for this stage. In the LO sensitivity setting of S3, a 2.00 V input yields a full-scale output (16 % signal change per LED). In the HI sensitivity setting of S3, a 0.301 V input yields a full-scale output (2 % signal change per LED).

9.5.6.2 Manual Threshold Reference

This stage provides a front panel user-adjustable reference. The user adjusts the threshold value with R3 (THRESHOLD). While the threshold can only be set up to 5 V (10^{-8} amps), the input can be "measured," and changes in it observed, up to 7 V (10^{-6} amps) at the LO sensitivity setting with R3 set to 5V and a full-scale LED display.

9.5.6.3 Automatic Tracking Threshold Reference

This circuit follows the input voltage, but with a lag time defined by the RC time constant of R5 x C2 of 10 seconds. Pressing S1 (RESET) shortens the time constant to 10 milliseconds, thereby causing an immediate update to the current input value. This mode of threshold setting does not allow the user to know the threshold value. To determine this, the user must switch back to MANUAL THRESHOLD. Unlike the MANUAL THRESHOLD stage, the range of this stage is unlimited and will track the input over its full 8 V range.

9.5.6.4 Audio Bias/Clamp/Filter/Inversion Stage

This stage serves to turn the 0 to 3.75 V response range into -0.5 to -2.0 V with respect to the +12 V supply as required by the LM566CN VCO stage it feeds. In addition, it limits the maximum output response to -2.0 V despite the fact that the outputs from the Input Amp stage will exceed 3.75 V. The maximum DAC update rate will be about 0.1 seconds.

9.5.6.5 VCO

This stage provides a 250 Hz to 4 kHz triangle wave output at 2.4 V peak-to-peak for the audio amplifier stage. The threshold pitch is user adjustable over about 250 Hz to 1 kHz (2 octaves) via R11 (PITCH). The input of -0.5 to -2.0 V on pin 5 of U2 provides a four-fold (2-octave) increase in pitch from threshold to full scale response.

9.5.6.6 Audio Amplifier

This stage AC couples the input triangle wave to the LM3090N using R121-R122 to limit the maximum input value to just allow a roughly square wave at the speaker output. This provides optimum power and audibility from the audio amplifier.

9.5.6.7 LED Bar Graph Display

This stage consists of the bar display drivers and the LED bar graph display of 30 LED segments. R25 to 27 define approximately 0.1 times the current drawn from each LED segment. The nominal value for this is 0.8 mA, however, variations in display segment brightness requires that components be matched for optimum uniformity.

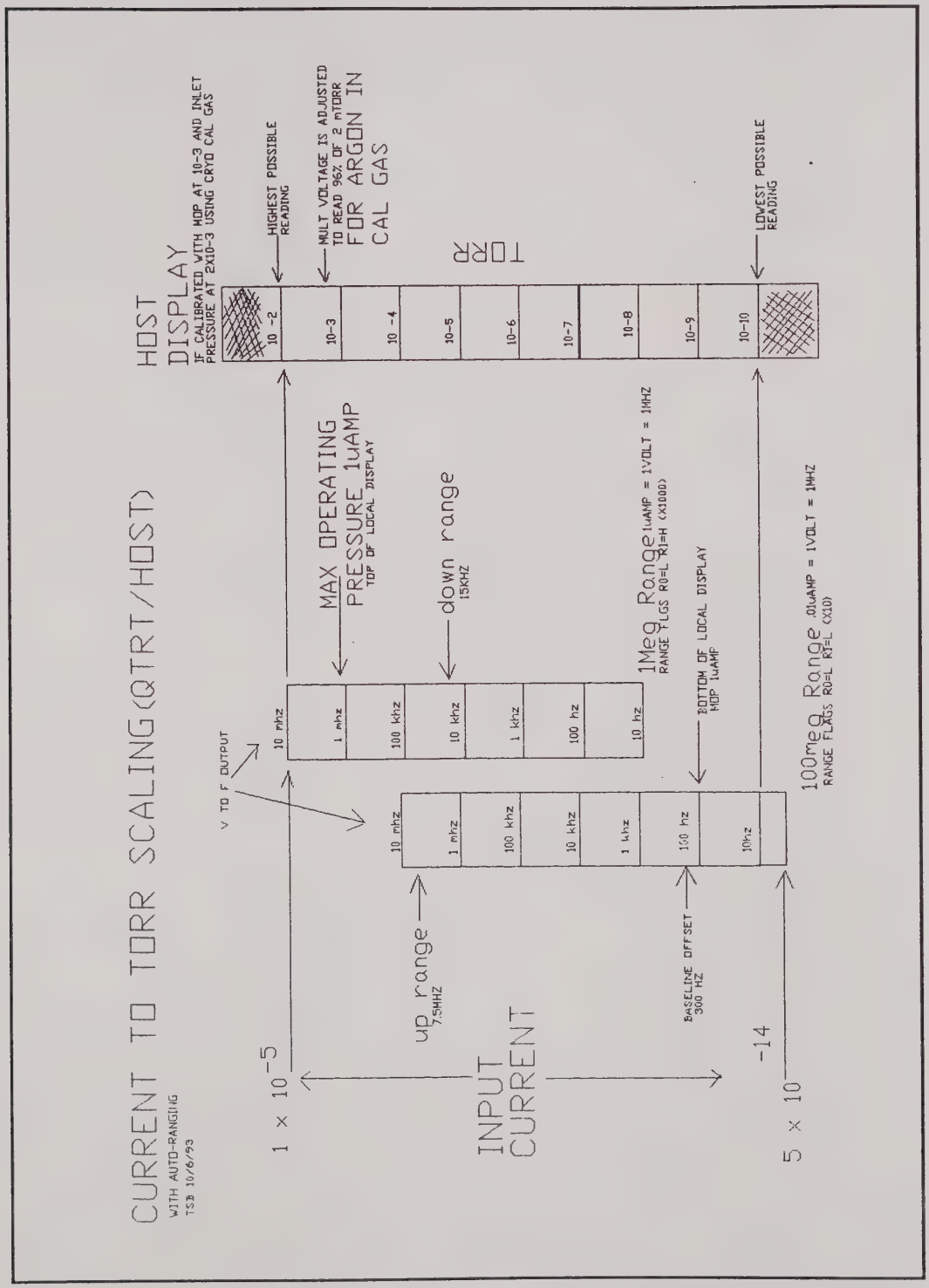


Figure 9-8. Auto-Ranging Scaling

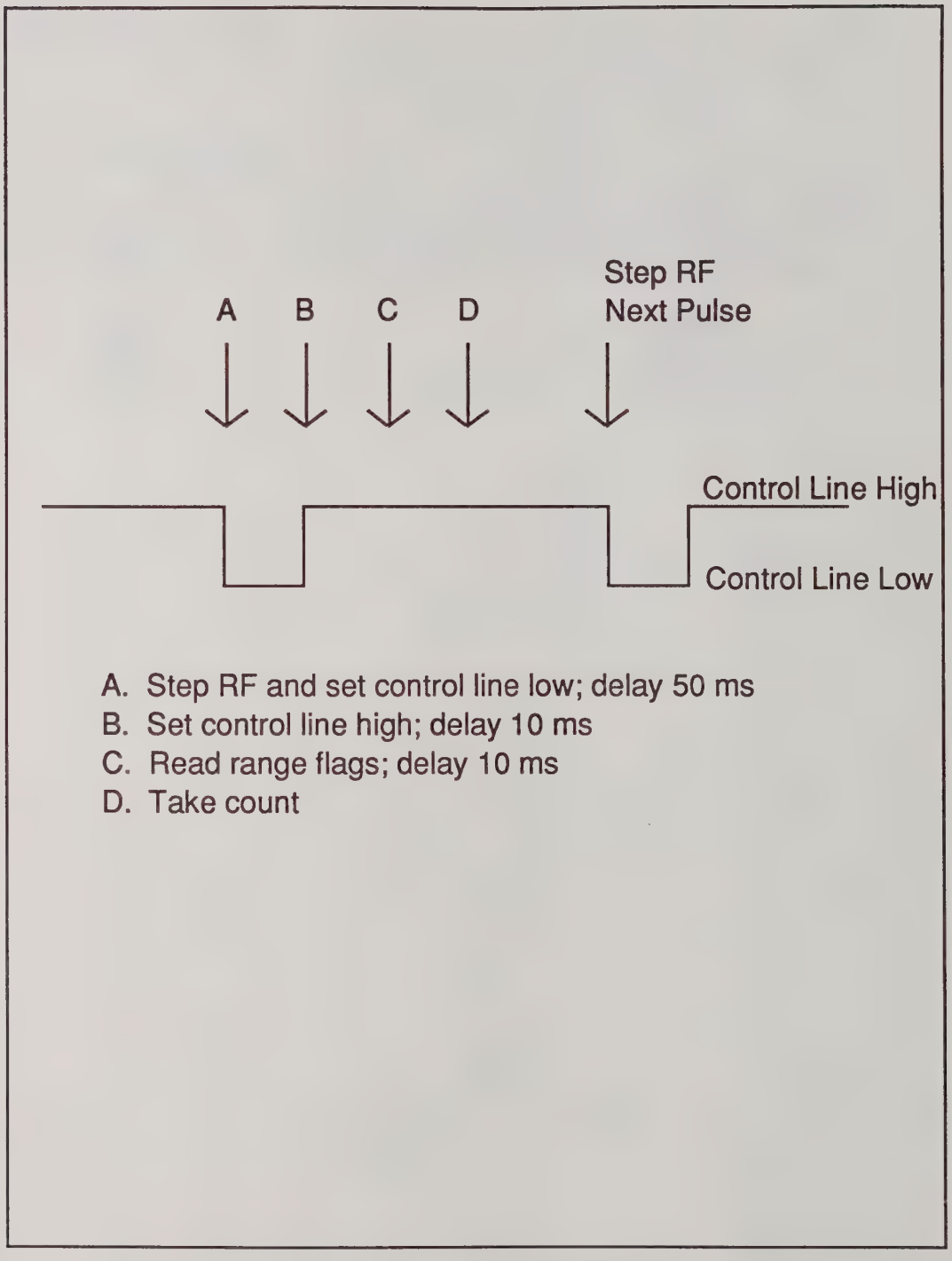


Figure 9-9. Auto-Range Control Line Timing

Chapter 10

Troubleshooting

This chapter provides a summary of possible problems and their respective solutions by the use of step-by-step troubleshooting procedures. The procedures are referenced to the specific section in the manual where the required adjustment is described in detail.

The basic troubleshooting procedure to isolate and correct problems with your QualiTorr Remote System is to proceed in the following sequence:

1. Host Computer
2. Station Controller
3. Station Probe

10.1 Basic Troubleshooting Summary

The most common troubleshooting issues are listed below.

The user can sometimes facilitate the troubleshooting of a system by checking for some common problems before calling UTI Service personnel.

If the system is showing one of the following four failure modes, try the steps listed under each failure mode (A, B, etc.).

1. Station power lamp off

   A. Check for disconnected power cable.

   B. Check fuse on back panel of the station controller.

2. "Station Not Responding" message on display

   A. Check for disconnected COM (RS485) cables.

   B. Try software restart of network.

   C. Check that station disk is not write protected.

   D. Try cold reboot of the station controller.

   E. Using VGA display and IBM keyboard on the station controller front panel ports, check for CMOS checksum failure. (This can be caused by cycling power.)

3. "Open Filaments" message on remote status display

   A. Check for disconnected cabling at RF and Probe.

   B. Set EMV to 700V, then reboot system and restore EMV or recalibrate system (especially if MHV is high > 2000V).

   C. Try cold reboot of the station controller.

10.2 Power Loss

1. Check the line cord and ensure that there is power at the source power connector.

2. Check the fuses at the back of the control console. Reference: Section 5.9.20.

10.3 Flat Baseline/No Spectrum

1. Check the +5 VDC power supply. Reference: Section 6.2.

2. Check the +10 VDC power supply. Reference: Section 6.6, TP2 and R13.

3. Check the -10 VDC power supply. Reference: Section 6.6, TP1 and R26.

4. Check the +12 VDC power supply. Measure the voltage at either Q1 or Q2 on the serial interface card at the left , back, inside corner of the open console (as you face the control console).

5. Check the +15 VDC power supply. Measure the voltage on the Analog I/O Board between Pin 1 and Pin 2 (ground) on Plug P2.

6. Check the -15 VDC power supply. Measure the voltage on the Analog I/O Board between Pin 3 and Pin 2 (ground) on Plug P2.

7. Check the +18 VDC and - 18 VDC power supplies Measure the voltage on the RF Control Board (on the top of the RF Generator Module) at Q7 and Q8.

8. Check the +32 VDC power supply. Measure the voltage on the RF Control Board (on top of the RF Generator Module) between R8 and ground.

9. Check the status LEDs on the Control Board. Reference: Section 6.4. If the DS4 status lamp is on, or the DS5 lamp is out, check the filament continuity at the probe flange. Also check for shorts to the ionizer grid or focus plate before removing the probe and replacing the filament(s). References: Section 6.11 to make the measurements, Section 5.3 to remove and replace the probe, and Section 5.4 to remove and replace the Ionizer Filaments.

10. If status lamp DS6 (FP) is on, the control console will need to be powered down using the switch on the Control Board. Then, check to ensure that the probe chamber has a pressure less than 10^{-5} Torr before turning the console back on and rebooting. If the probe was up to air pressure and then pumped down without baking before the filaments were turned on, the protect circuit may be detecting outgassing of water that triggers the filament protect circuitry. If this has occurred, turn down the emission potentiometer (Reference: Section 6.4, R10) to zero and slowly turn it up to let the filaments outgas in a slower, more controlled manner.

11. The next step is to check the four power supplies on the Ionizer Board. The health of the ionizer subsystem can be quickly checked by measuring the emission and the voltages at the respective test points and making any required adjustments. Measure the voltages with respect to the Ionizer Board Ground Test Points at TP7 and TP8. Reference: Section 6.3.

12. Check the Voltage Ion Current (VIE) Test Point. Reference: Section 6.3, TP1.

13. Check the Emission Test Point. Reference: Section 6.3, TP2.

14. Check the Faraday Cup (FC) Test Point. Reference: Section 6.3, TP3.

15. Check the Voltage Electron Energy (VEE) Test Point. Reference: Section 6.3, TP4.

16. Check the Voltage Focus (VF) Test Point. Reference: Section 6.3, TP5.

17. Check the Current Focus (IF) Test Point. Reference: Section 6.3, TP6.

18. Check the Multiplier Voltage Test Point on the Electron Multiplier Board. Reference: Section 6.1, TP3.

19. Check the Electrometer Test Point on the Digital I/O Card. Conduct the "finger test" while the console is in programmable scan. Reference Section 6.7, TP7.

> NOTE
>
> **The following procedures require the use of an oscilloscope to measure the RF voltages.**

20. Put the RF system in the *Tune* mode by switching S1 on the RF Power Board from *Normal* to *Tune*. Reference: Section 6.9, S1.

21. Check to ensure that the RF voltage at the RF Test Point on the RF Control Board is 20 VAC by measuring the peak on a scope. Reference: Section 6.10, RF.

22. Return the RF System back to the Normal mode by switching S1 on the RF Power Board from *Tune* to *Normal*. Reference: Section 6.9, S1.

23. Ensure that the RF tracks the output of the scan DAC. If it doesn't, you will need to troubleshoot the RF Control Board. If the RF is OK, proceed to Step 24.

24. Check the voltage at the output of the +DC and -DC rod amplifiers. Make the measurements on the Rod Driver Board, Pin 1 of J8 and J4. These voltages should track the scan output of the DAC at approximately 0.5 VDC per AMU. If this is confirmed, the mass spectrometer may be OK.

25. Check the total pressure of the gas sample. The sample gas may not be getting to the system. Check the orifice diameter for the process chamber pressure that is being used. Ensure that you are operating in the optimum pressure range for the probe. Reference: Appendix B.

26. Conduct a programmable scan of a known gas mixture. The UTI standard gas mixture is highly recommended. Analyze the resolution characteristics of the resulting spectrum. Perform an adjustment of the Low Mass Resolution Adjustment and the High Mass Resolution Adjustment. Reference: Section 6.10, R43 and R46.

> NOTE
>
> The UTI Calibration Gas is extremely useful for determining the health of the QualiTorr Remote. A Programmable Scan is used to confirm proper resolution, isotope abundance, and mass location of the known and well characterized spectrum. The UTI Calibration gas is a mixture of 1 percent each of hydrogen, helium, argon, krypton, and xenon in 95 percent nitrogen. This mixture provides groups of peaks over a wide range of AMU. Low and high mass groups provide an opportunity to check and adjust the spectral characteristics, as required to maintain a properly tuned instrument. Knowing that the system is displaying a "healthy" spectrum allows the user to have a high degree of confidence in the quality of data that is coming from the process analyses.

SPECIAL NOTE

THE FOUR CRITERIA FOR SPECTRAL HEALTH

1. Mass Location
   - Is the resolution at the low mass peaks (H2 or He) OK?
   - Is the high mass peak (Xe) location OK?
   - Is the location of the peaks linear across the mass range?

2. Resolution
   - Is the resolution at the low mass peaks (H2 or He) OK?
   - Is the resolution at the high mass peaks (Xe) OK?
   - Is the resolution of the peaks linear across the mass range?

3. Base Line Offset
   - Is it trimmed to the right offset value (5 $1/2$ decades below Maximum Operating Premise (MOP) at the top of the monitor screen)
   - Is it flat across the mass range?

4. Sensitivity *Signal-to-Noise*
   - Is your multiplier high voltage too low?
   - Is the instrument in saturation?
     Is the sample inlet pressure too high?
     Is the multiplier high voltage too high?
   - Is the noise repeatable?
     Is your noise unexpected peaks?
     Is your vacuum system dirty?
   - Is your ionizer OK?
     Are the ionizer voltages (VIE, VEE, VF) OK?
     Is the electron emission OK?
     Are the ionizer filaments out of alignment?
     Could the ionizer be contaminated?
     Is the bellows out of the ionizer sample input?
   - Could the multiplier be defective?
     Is the noise from field emission?
     Could the multiplier be contaminated?
     Has the multiplier suffered a loss of gain?

10.4 Poor Sensitivity

The following multiple-step procedure has been organized so that troubleshooting Steps 1 through 8 and 14 are applicable for both open and closed source probes. Steps 9 through 13 are applicable to only closed source configurations.

1. The mass location calibration may need adjustment. Conduct a programmable scan around 40 AMU with a scan width of 12 AMU. Check the mass location calibration by ensuring that the orange mass marker on the display is centered on 40 AMU. If the mass location is less than 0.5 AMU out of calibration, perform the calibration procedure (see Section 4.5.3). If the mass location is off by more than 0.5 AMU, a mass location calibration should NOT be performed until the analog electronics are re-adjusted. Reference: Section 6.10.

2. Confirm that the pressure of gas being analyzed has not decreased. Confirm that there is an adequate sample pressure by closing the valve between the turbomolecular and mechanical pump. Check pressure differences with different valves open and shut while monitoring the TC gauge. Use the recalibration reset zero to compare pressure differences between the different sampling conditions. For example, leak argon or the UTI calibration gas into the process chamber so that the pressure in the chamber is approximately 2×10^{-3} Torr. Note the pressure at the TC gauge when the inlet valves are all shut and compare this reading with the pressure measured when one or more of the orifice valves are open. Then, compare this pressure to that obtained when the main conductance valve is open.

3. The electron multiplier may be causing the problem. If the pressure at the electron multiplier should increase to 10^{-3} Torr or above, for any reason, while the multiplier is On, the electron multiplier could go into a glow-discharge and become damaged.

   If the electron multiplier is exposed to contamination, its efficiency will be decreased. A possible source of this contamination is from the mechanical pump. The mechanical pump oil may have back-streamed into the probe chamber while the TMP was Off or on Standby. Another possible cause of electron multiplier loss of gain is from exposure to deleterious reactive gases containing halogenic compounds from the process chamber. This type of degradation usually occurs slowly over time.

   All electron multipliers degrade with age. The rate of aging will depend primarily on its working environment. As the gain of the electron multiplier decreases, the high voltage to the electron multiplier must be increased to re-establish the mass peak heights desired. **It is important not to expect an increase in electron multiplier voltage to make up for other probable causes of sensitivity loss discussed in this section.**

   If an electron multiplier needs to be replaced more often than each year, the user should investigate and determine the cause of the accelerated degradation. If adequate peak heights are achieved for more than one year, one can assume that adequate care has been given to the electron multiplier.

The Faraday Cup test procedure indicates whether the Ionizer circuitry is working properly. To test the sensitivity of the ionizer, establish normal operating pressure on the inlet and measure the Faraday Cup signal with Jumper J17 On (electron multiplier Off). With J17 off, the multiplier operates normally and should produce a signal several decades higher. If the pressure in the closed source ionizer is about 1 x 10^{-3} Torr, the Faraday Cup signal should be in the 10^{-9} to 10^{-10} Torr range if the ionizer is working correctly. See Figure 10-1.

4. The mass resolution calibration may need adjustment. If the mass location is OK, check the resolution of the peaks at the highest and lowest ends of the available spectrum. If the peaks are over-resolved, the sensitivity will be low. Reference: Section 6.10.

5. Check the Voltage Ion Energy (VIE) Test Point, Voltage Electron Energy (VEE) Test Point, Voltage Focus (VF) Test Point, and Emission Test Point. Reference: Section 6.3, TP1, TP4, TP5, and TP2, respectively.

6. Check the serial numbers on the probe, the software, and the RF Generator being used. If the probe and RF generator have been switched from their original combination, the QualiTorr Remote will be out of calibration and the sensitivity will be drastically reduced. UTI maintains extensive records on every QualiTorr Remote. You may need to contact UTI to ensure that the correct hardware and software components are matched.

7. Plugged orifices will reduce the sample pressure and, therefore, the signal will decrease. The most effective way to check the pressure in the ion source is to check the ratio of the dimer peaks to the parent peaks. If the ratio decreases, then this is a clear indication that the source pressure is not as high as it was before.

8. Noise increases due to mechanical vibration (microphonics), high electron multiplier voltage, broken cables, and loose connections can reduce the capability to detect ppm level signals. Ensure that the QualiTorr Remote is operating in a vibration-free environment and that the components are in good operating order. Check electrical grounding.

9. Many customers choose a "Short Probe" sampling system that utilizes a ball and socket gas connection to the ionizer. Another option is the standard length probe with a bellows tube connection.

   If the bellows is bent and thus located outside of the source chamber, the pressure inside and outside the source will be equal. The pressure above the turbomolecular pump will become excessive (note foreline pressure increase) and the pressure in the ionizer will be too low for proper operation. The symptom can be detected by observing the dimer peak to parent peak ratio; the ratio will be much smaller than usual. Also, the parent peak signal will be reduced by a factor of several hundred times. Note: dimers are a product of the reaction of an ion and a molecule.

   To correct this problem, remove the probe, readjust the bellows to a straight position. If the bellows has been compressed, decompress it. Then, replace the probe. The short probe is not likely to have an alignment problem. Reference: Section 5.3

10. Filaments can warp at power–on because of the sudden temperature change or inadvertent operation at high pressures. This distortion may move the filament away from its proper alignment with the electron aperture and will cause a reduction of the output signal. Visual inspection can ensure that each filament coil exactly bisects the hole in the reflector and the hole in the grid. It is important to ensure that the system inlet has first been pumped down to below 10^{-6} Torr. The filaments may then be turned On using the normal start-up procedure. Pressures above 100 mTorr in the Closed Source or above $1x10^{-5}$ Torr in an Open Source will cause tungsten filament warpage.

11. One of the filaments being broken will reduce the signal by 50%. The system will still operate, but it is time to plan to change the cylindrical reflector assembly (with its filaments). If the DS3 LED on the Control Board is illuminated (see Figure 6-3), a single filament may be burned out. If such an indication is given, the probe needs to be removed, and **both** filaments replaced. Reference: Sections 5.3 and 5.4.

12. A dirty ion source, and/or quadrupole probe could cause the signal to drop. This phenomenon will occur when the gas samples are condensable types such as high molecular weight hydrocarbons, pump oils, etc. Removing the probe from its chamber, pulling the probe apart, and cleaning the ionizer and probe should improve the detected signal level. Reference: Sections 5.3 and 7.2.3.

13. Excess pressure will also cause the signal to decrease. This is a linearity issue. For the Open Source probe, pressures in the probe region in excess of $1x10^{-5}$ Torr, damage the filaments and produce non-linear results. Doubling the gas pressure will no longer produce a signal that is twice as large. In fact, pressures in excess of $1x10^{-4}$ Torr actually cause signals to decrease. In the Closed Source, where the pressure inside the grid of the ionizer is likely to be around $1x10^{-3}$ Torr, it is important to remember than linearity should be accurate to about $4x10^{-3}$ Torr, however ion-molecule reactions take place at pressures in the 10^{-3} Torr range, so a clue to this possibility would be that the ratio of the dimer peak to the parent peak will be higher than usual. The inverse would also be notable, i.e., if the pressure is too low, the dimer signal will be too low as well, as in the case of a dislocated bellows.

14. Finally, peak height sensitivity that diminishes at either the high end or the low end of the mass range may be the result of improperly adjusted RF detector compensation. This adjustment, once done at the factory, rarely needs to be repeated. A procedure for checking this condition is given in Section 6.10. An oscilloscope and a UTI Scan Box are required for the procedure.

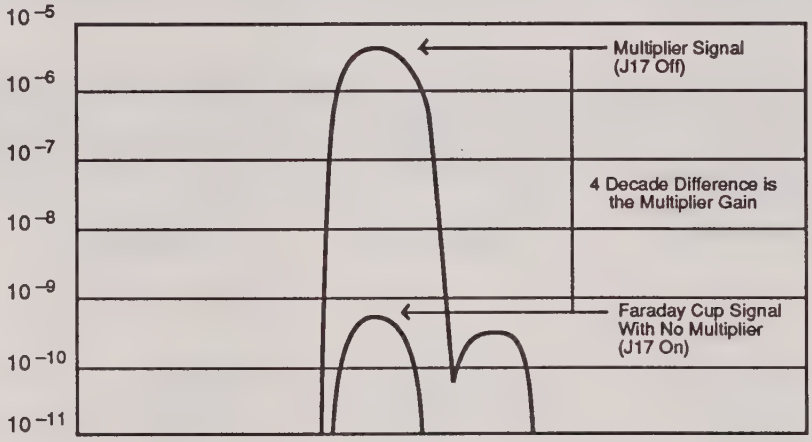


Figure 10-1. Faraday Cup Signal Adjustment

10.5 Monitor Baseline is Incorrect

The monitor should be between 1/8 to 1/2-inch (2 or 3 x 10^{-11}) above CRT zero. Do not make any adjustment until the Control Console has been on at least 30 minutes and has had a chance to reach thermal equilibrium. Adjust the monitor baseline at the Signal Processor Board. Reference: Section 6.7.

10.6 Computer Subsystem

Troubleshooting of the Computer Subsystem is provided in Chapter 8, *Computer Maintenance.*

10.7 Analog Subsystem

Reference: Figure 10-2

The Analog Subsystem consists of the Filament Supply, Ionizer Supply, Electron Multiplier High Voltage, Analog Control Board, DC Rod Supply, Multi-volt Supply, 5 VDC Supply, and the Analog Input/Output Board (see Figures 9-1 and 9-2). The troubleshooting logic tree is summarized in Figure 10-2.

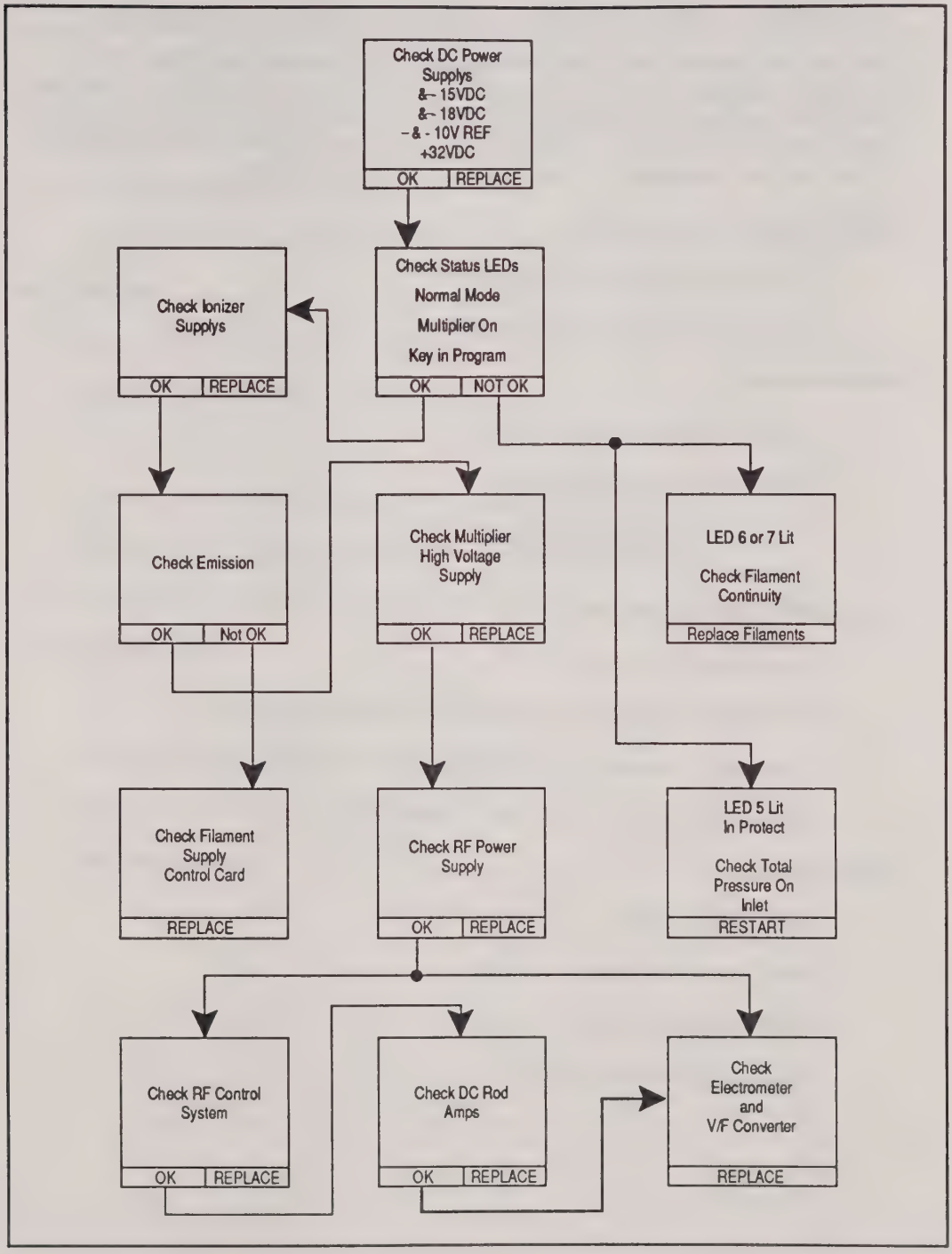


Figure 10-2. Analog Subsystem Troubleshooting Procedure

10.8 Station Controller Mass Spectrometer Subsystem

The Station Controller Mass Spectrometer Subsystem consists of the Multiple Voltages Card, Filament Supply, Electron Multiplier, Control Card, Ionizer Supplies, Rod DC Supplies, and the Analog Mother Board (see Figures 9-1 and 9-2). The following outline provides specific checks to localize the problem to a specific board or component.

Multiple Voltage Power Supply

Are the unregulated input voltages OK?

Are the regulated output voltages OK?

Filament Supply

Is the preregulated output +12 VDC?

Is the 4 VDC output voltage OK?

Is the power MOS gate voltage OK?

Electron Multiplier Voltage Supply

Is the DAC control voltage OK?

Is the output voltage OK? Is it 3000 VDC for a 10 VDC input?

Is the output voltage OK after disconnecting the output cable?

Are there any shorts in the cables or connectors?

Control Card

Is the emission OK?

What status LEDs are On and Off?

Is the Protect working?

Is the local +5 VDC supply OK?

Ionizer Supplies

Does the Electron Energy Supply provide -70 VDC referenced to VIE?

Does the Ion Energy Supply provide +2 VDC for a closed ion source or +15 VDC for an open ion source?

Is the Focus Voltage -20 VDC?

Is the Emission Current 0.3 mA for a closed source or 2 mA for an open source?

Rod DC Supplies

Are the + and -250 VDC supplies OK?

Are the + and -200 VDC preregulators OK?

Is the RF Detector input OK?

Do the (+) and (-) DC Rod Amplifiers step at 0.5 VDC per AMU?

Are the output voltages OK after removing the output cables?

Are there any shorts in the cables or connectors?

Analog Mother Board

Are the AC inputs to the rectifiers OK?

Are the DC outputs from the rectifiers OK?

Are the + and - Reference Supplies OK?

Are the + and -250 VDC supplies OK?

10.9 RF Subsystem

The RF Subsystem consists of the I to F Card, the RF Power Card, and the RF Control Card (see Figures 9-1 and 9-2). The following outline provides specific checks to localize the problem to a specific board or component.

I-to-F Card

Are the + and -15 VDC supplies OK?

Does the electrometer respond by touching it?

Is it possible to trim the baseline on the display CRT?

Is the V-to-F temperature regulator OK?

RF Power Card

Is the card receiving +32 VDC from the Control Console?

Is the +5 VDC Supply OK?

While in *Tune* Mode, is there RF output ?

While in Normal Mode, is the Card scanning?

RF Control Card

Are the + and -15 VDC Supplies OK?

Is the +32 VDC Supply OK?

Are the + and -5 VDC Reference Supplies OK?

In *Tune* Mode, is there 6 or 7 VDC at TP1?

Is the Error Amp OK?

Is the RF increasing in step with the scan input?

Are the mass spectra under- or over-resolved?

Are the mass locations of the peaks out of calibration?

Is the Temperature Regulator OK?

10.10 Probe Connections

References: Figure 10-4, Schematic 11-11A, and Assembly Drawing 11-11B.

All pins, except the -3 kVDC pin should read open to ground.

10.10.1 Electron Multiplier Pin (-3 kVDC)

The standard QualiTorr Remote uses a Cu/Be electron multiplier. This pin should read 16 megohms to ground with a Cu/Be electron multiplier.

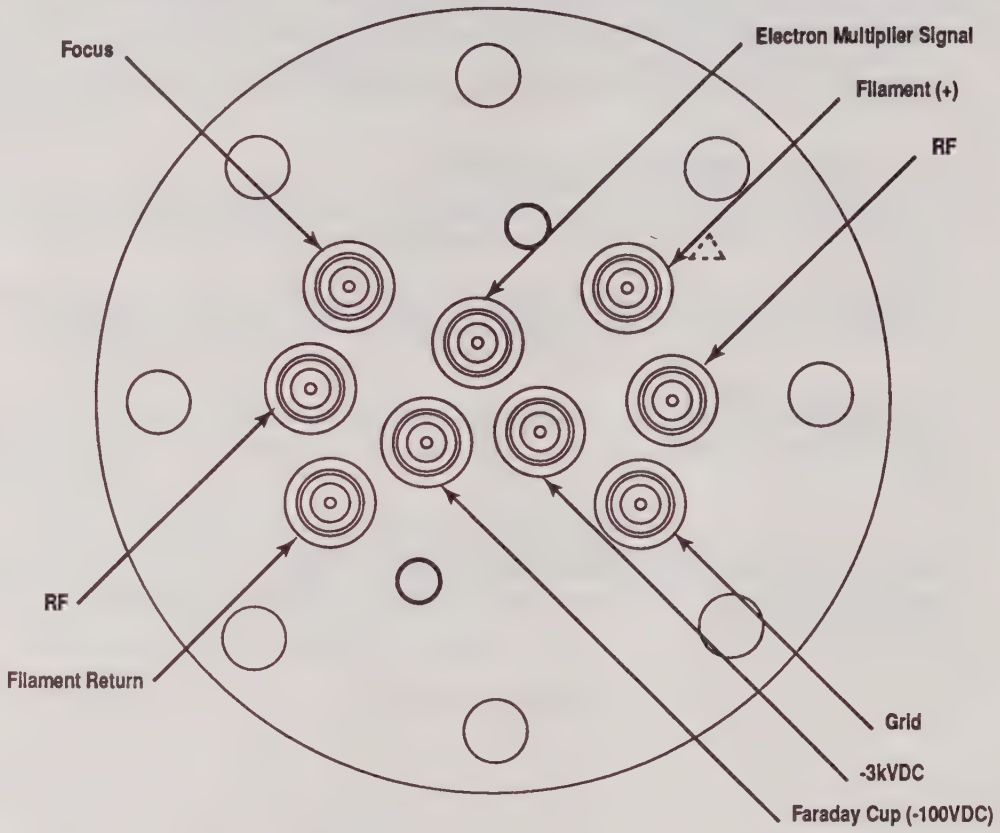
A Channeltron electron multiplier is available as an option. If a continuous dynode multiplier is installed, this pin should read approximately 80 megohms to ground.

10.10.2 Filament Pins

The two filament pins (plus and return) should read approximately 0.6 ohm across them.

10.10.3 RF, Grid, Faraday Cup, and Focus Pins

These pins should read open (greater than one megohm) with respect to each other and open to probe ground.



Probe Resistance Values

The normal Resistance of the probe pins to each other and flange ground is as follows:

- 3 KV pin (multiplier high voltage supply): 16 megohms to the flange (80 megohm with channeltron). Infinite resistance to all other pins.
- Filament (+) pin: 0.3 ohms to filament return (0.6 ohms single filament). Infinite resistance to the flange and all other pins.
- Filament return pin: 0.3 ohms to filament (+) pin (0.6 ohms single filament. Infinite resistance to the flange and all other pins.
- Multiplier signal pin: Infinite resistance to all pins and flange.
- Focus pin: Infinite resistance to all pins and the flange.
- RF pins: Infinite resistance to all pins and the flange.
- Grid pin: Infinite resistance to all pins and the flange.
- Faraday Cup pin: Infinite resistance to all pins and the flange.

Figure 10-3. Probe Flange Connections (External View)

10.11 QTRT Single Valve Station

These procedures are arranged in the order used to start up a cold system. Each step is accompanied by the items to check if the step fails. These procedures are intended to help quickly find a faulty assembly and replace it to restore operation.

A. VSC Startup

1. VSC power switch turned on, no activity "VSC dead"
   a. Check circuit breaker
   b. Check power cable
   c. Check power line, verify line voltage
   d. Replace VSC (entire chassis)
2. VSC fails initialization (flashing LEDs) or gauge error indication
   a. Check gauge cables
   b. Test with gauge simulator, if okay replace gauge
   c. Replace VSC if LEDs flash
3. VSC in standby, filament off or purge on fails
   a. Check if turbo is spinning down ignore purge lamp off
   b. Replace VSC, check QTRT filaments. If filament off, lamp was off
4. VSC fails pump down sequence
   a. Pump lamp will not light
      1. Wait three seconds and try again
      2. Replace VSC
   b. Rough pump lamp does not light
      1. Replace VSC
   c. Rough pump lamp lights but gauge #1 does not change reading
      1. Check if forline valve is opened
      2. Check cables to forline valve
      3. Check pneumatic gas pressure for valves
      4. Check VSC 24 volt supply
      5. Replace VSC
   d. Gauge #1 will not drop below .8 to 2 Torr
      1. Check if purge valve is open
      2. Check pneumatic pressure to purge valve
      3. Replace purge valve
      4. Check for gross leak
   e. Purge lamp stays on
      1. Sub turbo controller, replace turbo controller
      2. Sub/replace turbo cable
   f. Purge lamp turns off, then after an eight minutes turns on again
      1. Sub turbo controller, replace controller
      2. Sub/Replace turbo cable
      3. Sub/replace VSC
      4. Replace turbo pump
   g. Turbo pump lamp does not come on
      1. Repeat steps for "F" above

h. Set point #2 will not turn on, ready lamp will not turn on
   1. Check for vacuum leak
   2. Check for dirty trap
   3. Possible rough pump problem
   4. Blank off forline, see if pressure drops

i. Set point #1 will not turn on
   1. Repeat steps for "H" above

B. QualiTorr Remote Console/Host Computer Startup

1. QTRT power on, no activity
   a. Check line power connections
   b. Check fuse on QTRT back panel
   c. Replace QTRT controller

2. Ready lamp does not blink
   a. Try rebooting, check green disk lamp
   b. Try new station disk
   c. Check CMOS setup
   d. Replace QTRT controller

3. Video monitor switch on, no raster
   a. Check power line connections
   b. Replace monitor

4. Video monitor on and host computer switch on, raster but no video
   a. Check video cable to computer
   b. Check power to computer
   c. Replace host computer

5. Host fails to boot, no time and date requested
   a. Check CMOS setup
   b. Try booting off floppy with diagnostic software (checkit)
      1) Run diagnostics on CPU, memory, and hard disk
      2) If hardware is okay, try to reinstall software
   c. Replace host computer

6. Host fails UTI software startup
   a. Reinstall software
   b. Replace host computer

7. Activate network, station fails to respond
   a. Reactivate network one station at a time
   b. Check that station ready LED is blinking
   c. Check cabling of RS485 net, check for pushed-in pins
   d. Check that station disk is not write protected
   e. Cable one station at a time to isolate problem
   f. Replace station controller

C. QualiTorr Remote Console Check-Out Analog Electronics (using local software)

1. Station fails to run a normal analog scan
   a. Flat baseline, no peaks
      1) Check vertical scale on host is set right to see baseline
      2) Check status of filaments, protected or open
         a) Measure filament continuity at probe
         b) Check probe for spread fingers on feed through
      3) Check status of EMV, has it been set too low
      4) Check test points for emission, VIE, VEE, and VF
         a) If VIE, VEE, VF and/or emission are not normal, then disconnect interconnect at RF and recheck. If VIE, VEE, and/or VF return to normal, then it is likely the probe has an internal short in the ionizer. Replace ionizer.
         b) Disconnect interconnect cable if VIE, VF, and VEE do not return to normal, then replace the remote station controller
      5) Check to see if spectra is over resolved
         a) Short rod DC to GND at RF or rod board. If a false peak appears on analog display, then you are likely over resolved
         b) Sub or replace controller
         c) Sub or replace RF, retune readjust
      6) Run analog scan in FC mode
         a) If FC spectra is normal, the problem is likely in mult HV power supply or the multiplier
         b) Sub or replace controller
         c) Sub or replace RF
         d) Replace multiplier
      7) Flex electrometer input cable (RF to probe cable)
         a) If noise spiked don't appear, then it is likely that the signal processor or pulse counter has failed, then
         b) Sub or replace controller
         c) Sub or replace RF

D. Analog scan displays peak, but spectra is abnormal (using local software)

1. Check mass location, adjust if nominal is more than 1/4 AMU from center of peak
2. Check resolution, adjust if peaks are "pinched off" or in a "blob"
3. Check baseline, adjust if it has too low or too high
4. If you can't adjust or if adjustment fails to correct mass LOC and resolution or baseline, then
   a. Sub or replace console
   b. Sub or replace RF
   c. Replace probe
5. Check for badly split peaks
   a. Reverse rod DC in console or RF
   b. Retune RF and readjust resolution
   c. Reduce VIE and/or VF
   d. Try to isolate problem by swapping controllers, cables, and RF if problem stays with probe then replace probe
6. Check for noisy spectra
   a. If noise goes away if you lower mult HV, then most likely you will need to replace multiplier
   b. Are the probe to RF cables vibrating, then tie down cables or dampen vibration (for example, try wrapping solder wire around them)
   c. Check probe feed through for spread fingers and check RF probe connector on RF for dirty pins (looking for bad contacts)
   d. Connect chassis ground to signal GND in controller. If noise stops, then check for ionizer focus supply ECO# 2423. If noise does not stop, replace controller (or replace ionizer card with one that has the ECO MOD)
   e. Try to isolate problems by swapping controllers, cables, and RF. If the problem stays with the probe, then replace probe
7. Check for loss of sensitivity
   a. Check that you are inletting a sample gas at the correct pressure
   b. Do you need to run the mult HV up to 2 KV or over to see any peaks?
      1) Run an FC scan. If normal, change multiplier
      2) If not normal, then check steps in C.A.4 and 5 above.
   c. Try to isolate problem by swapping controllers, cables, and RF. If the problem stays with the probe, then replace the probe
8. Check for signal recovery time by running Hi/Low test
   a. If test fails, replace or sub RF (or signal processor card)
   b. If replacing the RF does not solve the problem, then replace multiplier

9. Check for signal stability by running a dynamic scan for one hour or more. If signal is unstable then check the following:
   a. Ensure that your inlet pressure has not changed
   b. Measure the ionizer test points for a change
      1) If changed, swap controller
      2) If not controller, check ionizer for leakage
   c. Measure the multiplier HV test point if not stable, change controller (multtiplier HV supply)
   d. Check mass location and resolution adjust if necessary. If not stable (it drifts), make sure system is warmed up. If the system is warm then change RF
   e. Try to isolate problem by swapping controller, cables, and RF. If the problem stays with the probe, replace probe

Chapter 11

Parts List

This chapter contains the parts breakdown of the QualiTorr Remote System and the Field Replaceable Units (FRUs). The QualiTorr Remote System has been divided into components that are described in the tables that follow. The tables contain the respective descriptions and FRU part numbers that must be used when ordering replacement parts or assemblies.

11.1 QualiTorr Remote Systems

Table 11-1. Available QualiTorr Remote Systems

Description	Part Number
UTI Host Computer	04829
Station Controller	05574
Station Probe: Complete Open Source Sampler	04960-1100
Station Probe: Complete Closed Source Sampler	04960-2100
Station Probe: Complete Fast Inlet Sampler	04960-3210
Station Probe: Complete APSM Inlet Sampler	04960-2710

11.2 QualiTorr Remote System Options

Table 11-2. System Options

Description	Part Number
Gas Purge System, N_2	04260
Gas Calibration System	04214
RF Generator	04020
Closed Ion Source Probe	03911-2111
Open Ion Source Probe	03911-1111
Leak Hunt Assembly	04014
Printer	04679
Printer, HP 550C	14647

11.3 Open Ion Source Probe

Table 11-3. Open Ion Source Probe and Assemblies

Description	Part Number
Open Ion Source Probe (Series-30) (Long)	03911-1111
Open Ion Source Probe (Series-30) (Short)	03911-1351
RF Generator	04020
Reflector with Tungsten Filaments	03900-0001
Reflector with Thoriated Iridium Filaments	03900-0002
Ionizer with Tungsten Filaments	03899-0011
Ionizer with Thoriated Iridium Filaments	03899-0012
Electron Multiplier, Copper/Berylium (Long)	05174
Electron Multiplier, Continuous Dynode (Short)	05564
10-Foot Cable	04128-0010
25-Foot Cable	04128-0025
50-Foot Cable	04128-0050
75-Foot Cable	04128-0075
100-Foot Cable	04128-0100

11.4 Closed Ion Source Probe

Table 11-4. Closed Ion Source Probe and Assemblies

Description	Part Number
Closed Ion Source Probe (Series 30)	03911-2111
Fast Response Closed Source Probe (Short)	03911-3351
Reflector Assembly with Tungsten Filaments	03930
Reflector Assembly with Thoriated Iridium	03930-0002
Ionizer Assembly with Tungsten Filaments (Closed Source)	03497
Ionizer Assembly with Thoriated Iridium (Closed Source)	03497-0022
Ionizer Assembly with Tungsten Filaments (Fast Response)	04235
Ionizer Assembly with Thoriated Iridium (Fast Response)	04235-0022
Filaments, Tungsten (Pair, Standard)	02878
Filaments, Thoriated Iridium (Pair, Special)	04375-0020
Electron Multiplier, Copper/Berylium (Long)	05174
Electron Multiplier, Continuous Dynode (Short)	05564
RF Generator	04020
10-Foot Cable	04128-0010
25-Foot Cable	04128-0025
50-Foot Cable	04128-0050
75-Foot Cable	04128-0075
100-Foot Cable	04128-0100

11.5 QualiTorr Remote Station Controller

Table 11-5. Station Controller Printed Circuit Boards and Assemblies

Description	Part Number
Mother Board, Rectifier Assembly	04935
Rod Driver Board Assembly	05575
Ionizer Board Assembly	04070
Control Board Assembly	04360
Power Supply Board, Electron Multiplier, 3 keV Assembly	04005
Power Supply Board, Filament Assembly	05315
Analog/Digital I/O Board Assembly	04830
Video Graphics Adapter Board (VGA)	14151
Hard Disk/Floppy Disk Controller Card	14554
Disk Drive Floppy (1.44 MB)	14148
Battery, 6.0 VDC Lithium	14509
CCA, AT Dual RS-422/485	14404
CCA, AT, 386-33, w/1 MB RAM	14609
VGA Monitor (Maintenance)	14413
AT Keyboard (Maintenance)	14347

11.6 QualiTorr Remote UTI Host Computer

Table 11-6. UTI Host Computer Circuit Boards and Assemblies

Description	Part Number
Host Computer Assembly, 80386 CPU, 33 MHz, 40 MB HD, AT Keyboard, VGA Monitor, 1.44 MB FD	04829
Computer, 80386 CPU, 33 MHz, 40 MB HD, 1.44 MB FD	14412
VGA Monitor	14413
AT Keyboard	14347
CCA, AT Dual RS-422/485	14404

11.7 RF Generator

Table 11-7. RF Generator Circuit Boards and Assemblies

Description	Part Number
RF Signal Processor, F.C. and Auto Ranging Assembly	04415
RF Tank Assembly	04046
Interface Board Assembly	04143
RF Power Board Assembly	04025
RF Control Board Assembly	04030

11.8 Gaskets for Conflat Flanges

Table 11-8. Gaskets for Conflat Flanges

Description	Part Number
Copper Gaskets, 1.33-inch OD Flange	10852-0750
Copper Gasket, 2.75-inch OD Flange	10852-1500
Copper Gasket, 4.5-inch OD Flange	10852-2500
Gold-Plated Copper Gasket, 0.75-inch ID Diameter (1.33-inch OD Flange)	01488-0750
Gold-Plated Copper Gasket, 1.5-inch Diameter (2.75-inch OD Flange)	01488-1500
Gold-Plated Copper Gasket, 2.5-inch Diameter (4.50-inch OD Flange)	01488-2500
Gold-Plated Copper Gasket, 4.0-inch Diameter (6.00-inch OD Flange)	01488-4000
Gasket, Bonnet Seal, Gold Plated (4 BG and 8 BG Valves)	01489

11.9 Orifices

Table 11-9. Orifices

Orifice Diameter inch (mil)	Orifice Diameter m m	Material	Part Number
0.0010 (1.0)	0.025	Copper	01086-0010
0.0010 (1.0)	0.025	Gold Plated Copper	01462-0010
0.0010 (1.0) (x 12 holes)	0.025	Gold Plated Copper	03517-1201
0.0011 (1.1)	0.028	Gold Plated Copper	01462-0011
0.0014 (1.4)	0.036	Copper	01086-0014
0.0014 (1.4)	0.036	Gold Plated Copper	01462-0014
0.0015 (1.5)	0.038	Copper	01086-0015
0.0016 (1.6)	0.041	Gold Plated Copper	01462-0016
0.0018 (1.8)	0.046	Copper	01086-0018
0.0018 (1.8)	0.046	Copper	02150-0018
0.0018 (1.8)	0.046	Gold Plated Copper	01462-0018
0.0020 (2.0)	0.051	Copper	01086-0020
0.0020 (2.0)	0.051	Gold Plated Copper	01462-0020
0.0025 (2.5)	0.063	Copper	01086-0025
0.0028 (2.8)	0.071	Gold Plated Copper	01462-0028
0.0028 (2.8)	0.071	Copper	01086-0028
0.0030 (3.0)	0.076	Copper	01086-0030
0.0035 (3.5)	0.089	Copper	01086-0035
0.0040 (4.0)	0.102	Copper	01086-0040
0.0040 (4.0)	0.102	Gold Plated Copper	01462-0040
0.0045 (4.5)	0.114	Copper	01086-0045
0.0050 (5.0)	0.127	Copper	01086-0050
0.0050 (5.0)	0.127	Gold Plated Copper	01462-0050
0.0070 (7.0)	0.178	Copper	01086-0070
0.0070 (7.0)	0.178	Gold Plated Copper	01462-0070
0.0100 (10.0)	0.254	Copper	01086-0100
0.0100 (10.0)	0.254	Copper	03993-0100
0.0100 (10.0)	0.254	Gold Plated Copper	01462-0100
0.0140 (14.0)	0.356	Copper	01086-0140
0.0140 (14.0)	0.356	Gold Plated Copper	01462-0140
0.0200 (20.0)	0.508	Copper	01086-0200
0.0200 (20.0)	0.508	Gold Plated Copper	01462-0200

11.10 Vacuum Pumps

Table 11-10. Mechanical and Turbomolecular Vacuum Pumps

Description	Part Number
Mechanical Pump, Alcatel Model 2004B, 3.2 CFM	14604-0001
Turbomolecular Pump, Balzers Model TPU 060	14134
Turbomolecular Pump, Alcatel Model 5081UHV	14375-0001
Turbomolecular Pump, Model TPU 240	14583-0001
Electronic Controller, Balzers Model TCP 121	13791
Electronic Controller, Alcatel Model CFF 100	14375-0002
Vacuum System Controller (VSC)	04900-xxxx
Electronic Controller, Balzers Model TCP 120	13765

11.11 Two-Pressure Sampling Module (2PSM)

Table 11-11. Two-Pressure Sampling Module Components

Description	Valve Activation	Part Number 2PSM	APSM
Universal Analyzer Probe Chamber	N/A	03567	
Solenoid Valve, 115 VAC, 60 Hz	N/A	11336	
Low Pressure Valve Assembly	Pnuematic		04347
Low Pressure Inlet, Elbow	Pnuematic		04348
High-conductance Valve Assembly	Pnuematic		
High-conductance Valve, Support	N/A	03591	
Tube Bellows, CS	N/A	03564	
Universal Analyzer Probe Chamber	N/A	03567	
Low Pressure Valve Assembly	Manual		03974
Low Pressure Inlet, Elbow	Manual		03975
High-conductance Valve Assembly	Manual	03833	
High-conductance Valve, Support	N/A	03591	
Tube Bellows, CS	N/A	03564	
Gasket, Gold-plated Copper, CFF, 0.75-inch Dia. (1.33-inch OD Flange)	N/A	01488-0750	
Gasket, Gold-plated Copper, CFF, 1.50-inch Dia. (2.75-inch OD Flange)	N/A	01488-1500	
Stem Insert, Low Pressure Valve	Pneumatic	01490-0004	
Stem Insert, High Conductance Valve	Pneumatic	01490-0008	
Stem Insert, Low Pressure	Manual	04242-0004	
Stem Insert, High Pressure	Manual	04242-0008	

11.12 Three-Pressure Sampling Module (3PSM)

Table 11-12. Three-Pressure Sampling Module Components

Description	Valve Activation	Part Number
Universal Analyzer Probe Chamber	N/A	03567
Solenoid Valve, 115 VAC, 60 Hz	N/A	11336
Low Pressure Valve Assembly	Pnuematic	03832
Low Pressure Inlet, Elbow	N/A	03565
High-conductance Valve Assembly	Pnuematic	03831
High-conductance Valve Support	N/A	03591
Adapter, Twin-valve	N/A	03576
Tube Bellows, CS	N/A	03564
Universal Analyzer Probe Chamber	N/A	03567
Low Pressure Valve Assembly	Manual	03834
Low Pressure Inlet, Elbow	N/A	03565
High-conductance Valve Assembly	Manual	03833
High-conductance Valve, Support	N/A	03591
Adapter, Twin Valve	N/A	03576
Tube Bellows, CS	N/A	03564
Gasket, Gold-plated Copper, CFF, 0.75-inch Dia. (1.33-inch OD Flange)	N/A	01488-0750
Gasket, Gold-plated Copper, CFF, 1.50-inch Dia. (2.75-inch OD Flange)	N/A	01488-1500
Stem Insert, Low Pressure Valve	Pneumatic	01490-0004
Stem Insert, High Conductance Valve	Pneumatic	01490-0008
Stem Insert, Low Pressure	Manual	04242-0004
Stem Insert, High Pressure	Manual	04242-0008

11.13 Four-Pressure Sampling Module (4PSM)

Table 11-13. Four-Pressure Sampling Module Components

Description	Valve Activation	Part Number
Universal Analyzer Probe Chamber	N/A	03567
Solenoid Valve, 115 VAC, 60 Hz	N/A	11336
Low Pressure Valve Assembly	Pnuematic	03832
Low Pressure Inlet, Elbow	N/A	03565
High-conductance Valve Assembly	Pnuematic	03831
High-conductance Valve Support	N/A	03591
Adapter, Twin-valve	N/A	04405
Tube Bellows, CS	N/A	03564
Universal Analyzer Probe Chamber	N/A	03567
Low Pressure Valve Assembly	Manual	03834
Low Pressure Inlet, Elbow	N/A	03565
High-conductance Valve Assembly	Manual	03833
High-conductance Valve, Support	N/A	03591
Adapter, Twin Valve	N/A	03576
Tube Bellows, CS	N/A	03564
Gasket, Gold-plated Copper, CFF, 0.75-inch Dia. (1.33-inch OD Flange)	N/A	01488-0750
Gasket, Gold-plated Copper, CFF, 1.50-inch Dia. (2.75-inch OD Flange)	N/A	01488-1500
Stem Insert, Low Pressure Valve	Pneumatic	01490-0004
Stem Insert, High Conductance Valve	Pneumatic	01490-0008
Stem Insert, Low Pressure	Manual	04242-0004
Stem Insert, High Pressure	Manual	04242-0008

11.14 Atmospheric-Pressure Sampling Module (APSM)

Table 11-14. Atmospheric Pressure Sampling Module Components

Description	Valve Activation	Part Number
Atmospheric Pressure Sampling Module — Open Source	Manual	03969-1100
Atmospheric Pressure Sampling Module — Open Source Bolt-on Mount	Manual	03968-2100
Atmospheric Pressure Sampling Module — Closed Source	Manual	03970-1100
Atmospheric Pressure Sampling Module — Closed Source Bolt-on Mount	Manual	03968-1100

11.15 Software Options

Table 11-15. Software Options

Description	Part Number Version 1.1	Part Number Version 2.0
Red Ball Alarm	05491-H001	05513-H001
Remote Control of VSC	05491-H020	05513-H020
O. K. To Run	05491-Hxxx	05513-Hxxx

11.16 Hardware Options

Table 11-16. Hardware Options

Description	Part Number
Hand-Held Leak Detector	04014
Vacuum System Controller	04900-xxxx
Electronic Clean Room Cart	04381-Electronic
System Clean Room Cart	04381-Outrigger
Gas Calibration Bottle	13738
Gas Calibration System	04214
Cart Mounted Gas Calibration System	04424
Nitrogen Gas Purge System	04260
Color Printer	04679
Color Printer, HP 550C	14647
Scan Box	04222
Pneumatic Multiplier	14591

11.17 Interconnect Cables

Table 11-17. Interconnect Cables

Description	Part Number
10-Foot Cable from RF Generator to Station Controller	04128-0010
25-Foot Cable from RF Generator to Station Controller	04128-0025
50-Foot Cable from RF Generator to Station Controller	04128-0050
75-Foot Cable from RF Generator to Station Controller	04128-0075
100-Foot Cable from RF Generator to Station Controller	04128-0100
*25-Foot RS-485 Null Modem Cable from Host Computer to First Station Controller	04994-0025
*10-Foot RS-485 Multi-drop Cable from Station to Station Controller.	05309-0010
*10-Foot RS-485 Multi-drop Cable from Station to VSC Controller.	05312-0010

* Note: These two cables are nearly identical in appearance. Check part numbers on the cables and lengths to confirm their identities. These cables are **not** interchangeable.

11.18 User Manuals

Table 11-18. User Manuals

Description	Part Number
QualiTorr Remote Installation and Maintenance Manual	05522
User Manuals, QualiTorr III (QTRT Local Mode)	
Process Programmer - Pink	04861-3101
Maintenance and Calibration - Yellow	04861-3102
Process Operator - Blue	04861-3103
QualiTorr Remote Host Computer Operating Instructions (Host Computer Mode)	
Overview, Program Mode - Gold	05388-1101
Overview, Monitor Mode - Blue	05388-1102
Step by Step, Program Mode - Gold	05388-1103
Step by Step, Monitor Mode - Blue	05388-1104

11.19 Station Controller Mother Board Fuses

Table 11-19. Station Controller Mother Board Fuses

Description	Part Number
10 A CPU Mother Board Fuse	14169
15 A CPU Mother Board Fuse	14332

Chapter 12

Schematics and Assembly Drawings

This chapter provides a set of schematic diagrams and assembly drawings of the QualiTorr Remote Station circuitry.

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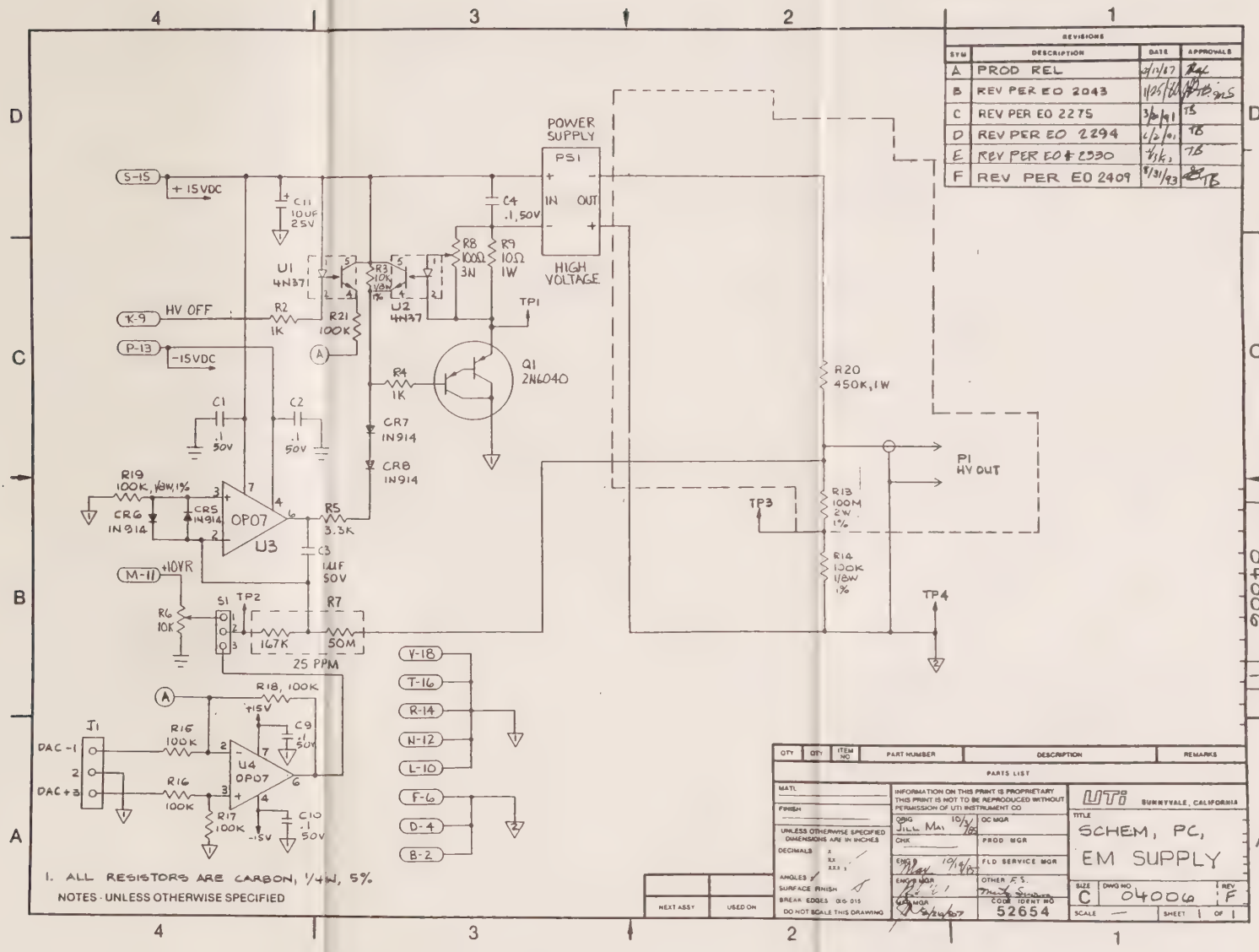


Figure 12-1A. Power Supply - EM SPLY (Electron Multiplier Board), Schematic

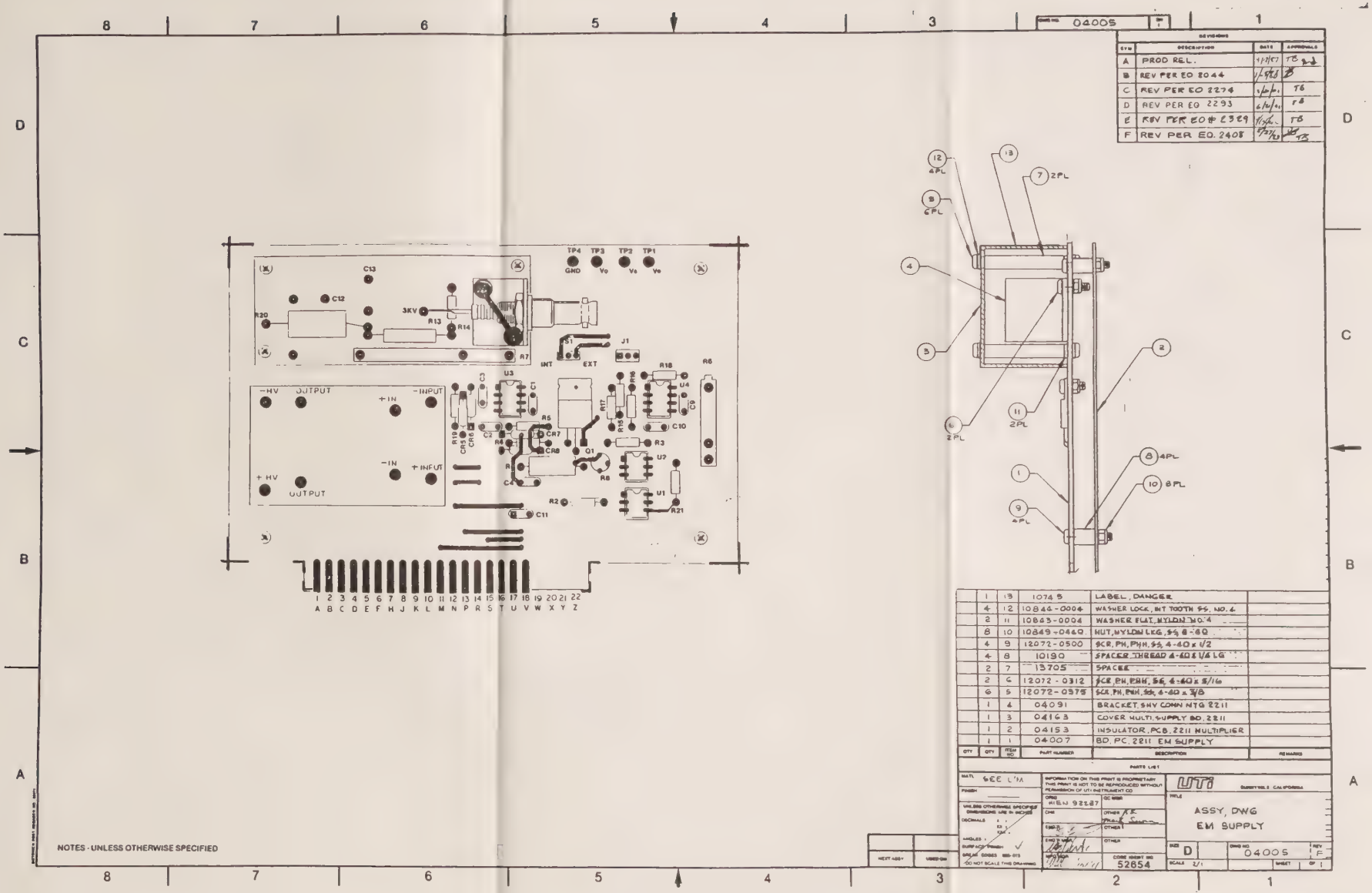


Figure 12-1B. Power Supply - EM SPLY (Electron Multiplier Board), Assembly Drawing

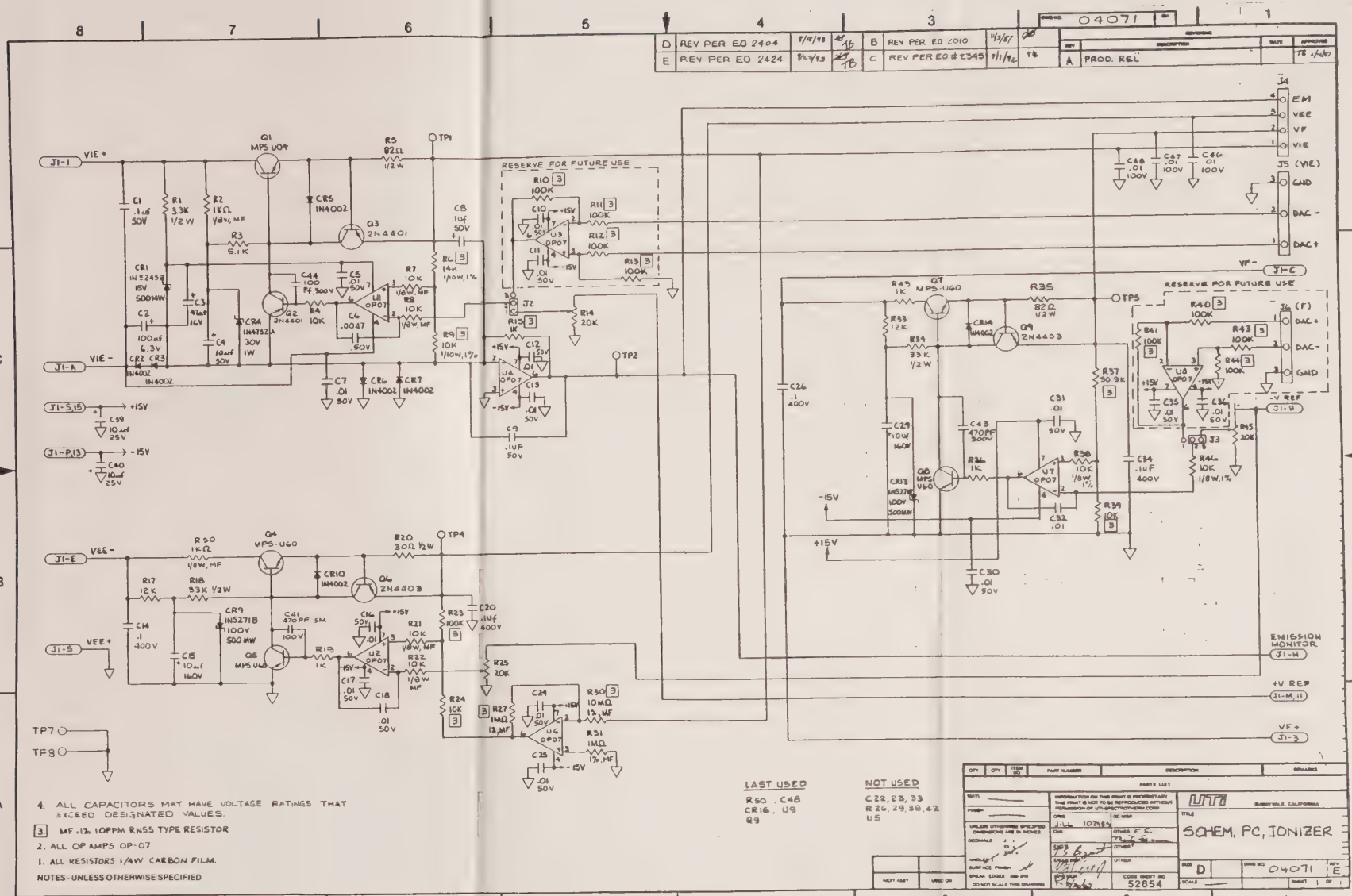


Figure 12-2A. Ionizer Board, Schematic

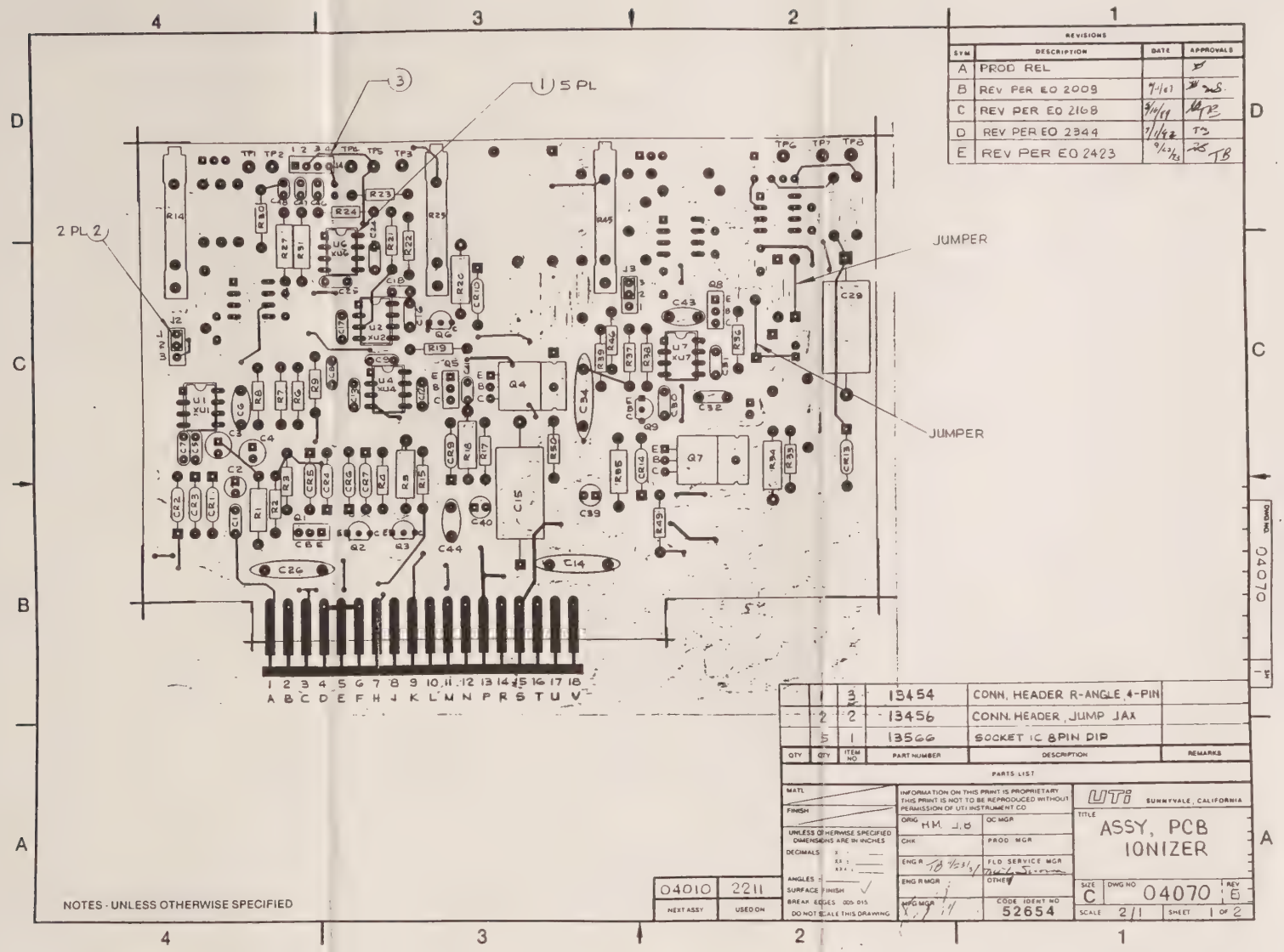

REVISIONS
SYM | DESCRIPTION | DATE | APPROVALS
A | PROD REL
B | REV PER EO 2009 | 7-1-81
C | REV PER EO 2168 | 3/14/89
D | REV PER EO 2344 | 7/1/92
E | REV PER EO 2423 | 9/23/93
3
1) 5 PL
2 PL 2
JUMPER
JUMPER
TP1 TP2 TP5 TP6 TP7 TP8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
A B C D E F H J K L M N P R S T U V
1 3 13454 CONN. HEADER R-ANGLE 4-PIN
2 2 13456 CONN. HEADER, JUMP JAX
5 1 13566 SOCKET IC 8PIN DIP
QTY | QTY | ITEM NO | PART NUMBER | DESCRIPTION | REMARKS
PARTS LIST
MATL
FINISH
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS
ANGLES
SURFACE FINISH
BREAK EDGES .005 .015
DO NOT SCALE THIS DRAWING
INFORMATION ON THIS PRINT IS PROPRIETARY. THIS PRINT IS NOT TO BE REPRODUCED WITHOUT PERMISSION OF UTI INSTRUMENT CO
ORIG H.M. 1.8
CHK
ENG R TB 9/23/93
ENG R MGR
MFG MGR
QC MGR
PROD MGR
FLD SERVICE MGR
OTHER
CODE IDENT NO 52654
UTi SUNNYVALE, CALIFORNIA
TITLE ASSY, PCB IONIZER
SIZE C | DWG NO 04070 | REV E
SCALE 2/1 | SHEET 1 OF 2
04010 | 2211
NEXT ASSY | USED ON
NOTES - UNLESS OTHERWISE SPECIFIED
DWG NO 04070 REV E

Figure 12-2B. Ionizer Board, Assembly Drawing

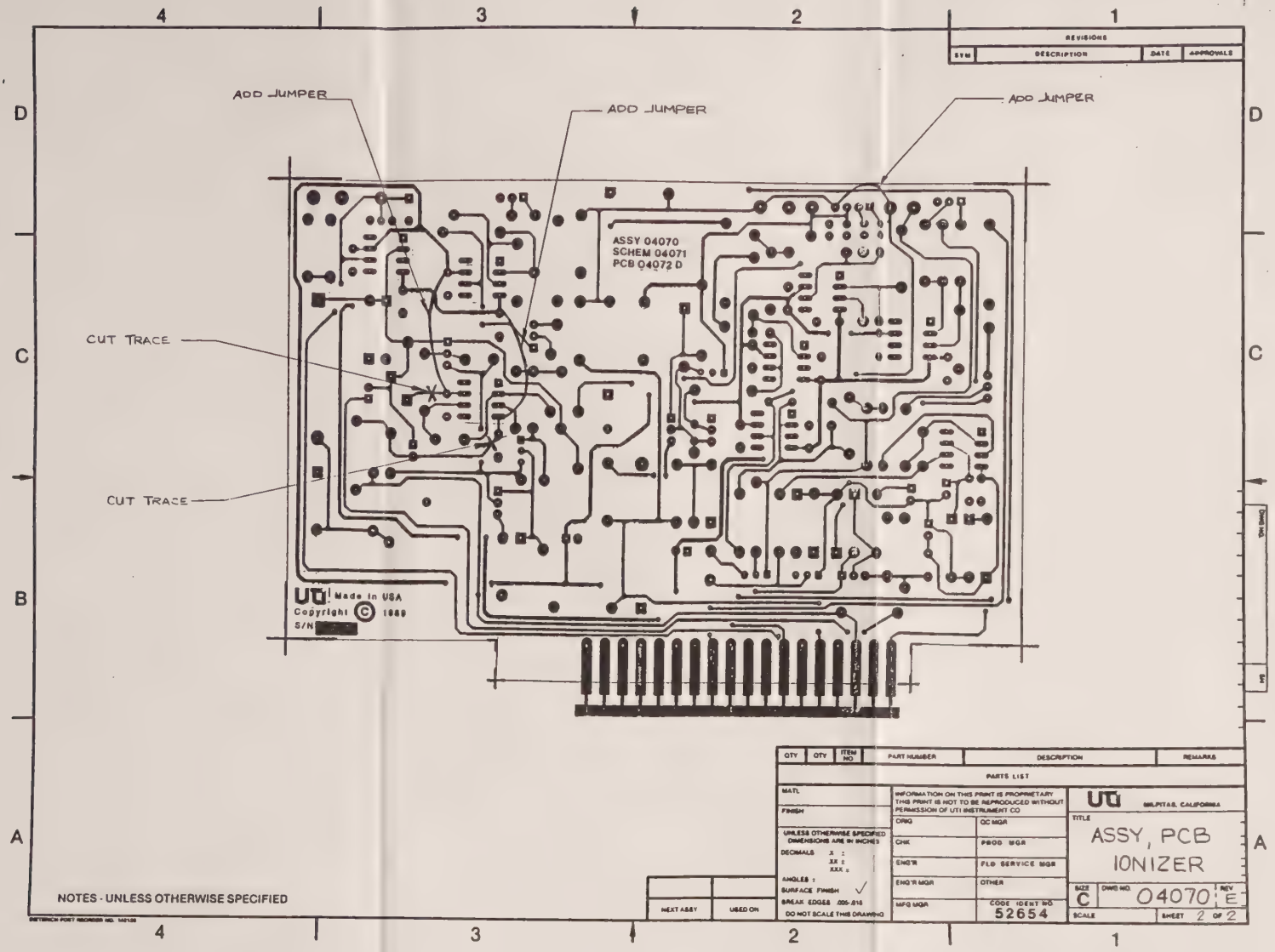


Figure 12-2C. Ionizer Board, Assembly Drawing (2/2)

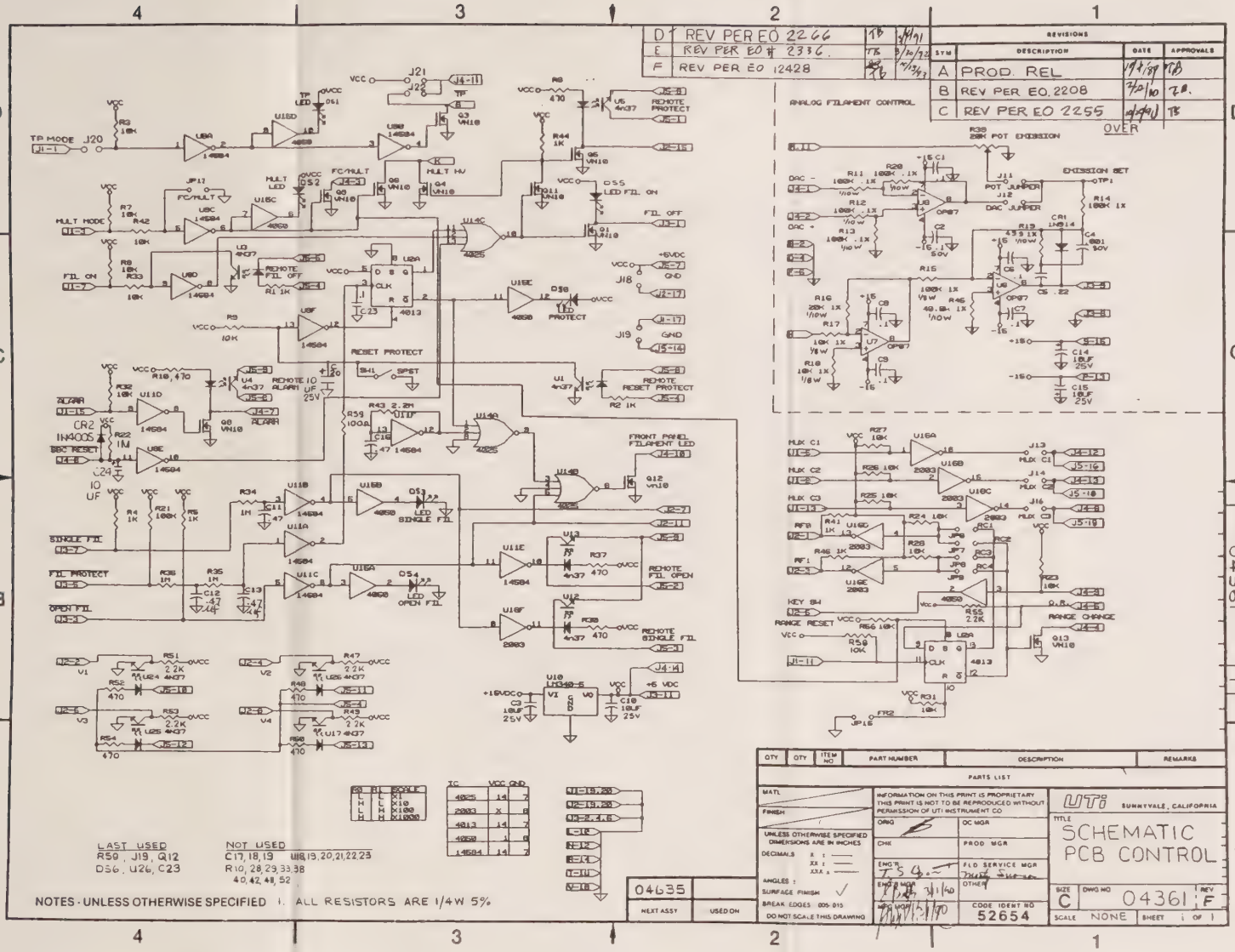


Figure 12-3A. Control Board, Schematic

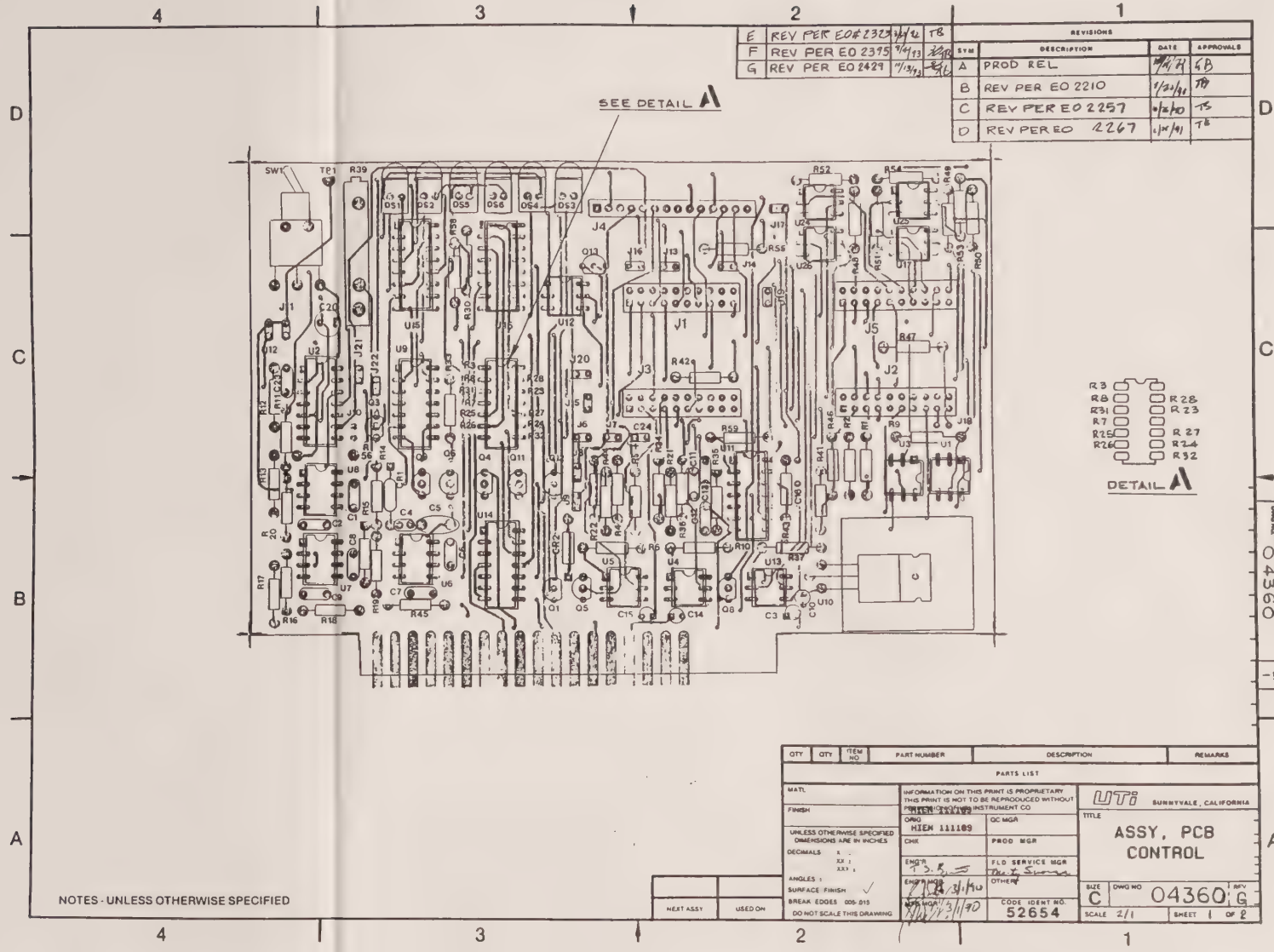
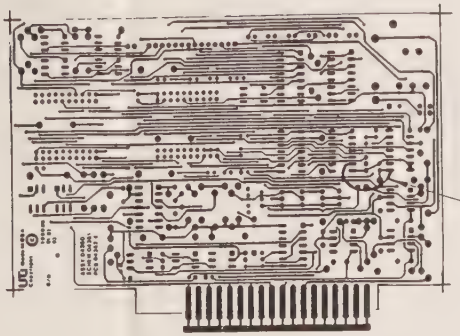

REVISIONS
SYM | DESCRIPTION | DATE | APPROVALS
A | PROD REL | 11/1/91 | GB
B | REV PER EO 2210 | 1/21/91 | TB
C | REV PER EO 2257 | 6/26/90 | TS
D | REV PER EO 2267 | 1/14/91 | TB
E | REV PER EO# 2323 | 7/5/12 | TB
F | REV PER EO 2375 | 7/4/13 | TB
G | REV PER EO 2429 | 7/3/14 | TB
SEE DETAIL A
DETAIL A
R3 R8 R31 R7 R25 R26 R28 R23 R27 R24 R32
PARTS LIST
QTY | QTY | ITEM NO | PART NUMBER | DESCRIPTION | REMARKS
UTi SUNNYVALE, CALIFORNIA
TITLE
ASSY, PCB CONTROL
SIZE C | DWG NO 04360 | REV G
SCALE 2/1 | SHEET 1 OF 2
CODE IDENT NO. 52654
NEXT ASSY | USED ON
NOTES - UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING
INFORMATION ON THIS PRINT IS PROPRIETARY THIS PRINT IS NOT TO BE REPRODUCED WITHOUT PERMISSION OF UTI INSTRUMENT CO

Figure 12-3B. Control Board, Assembly Drawing (1/2)



REVISIONS			
SYM	DESCRIPTION	DATE	APPROVALS

QTY	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REMARKS

PARTS LIST

MATL

FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS X : ±.1 ; XX : ±.01 , XXX : ±.005

ANGLES : ±1°

SURFACE FINISH ✓

BREAK EDGES .005-.015

DO NOT SCALE THIS DRAWING

INFORMATION ON THIS PRINT IS PROPRIETARY. THIS PRINT IS NOT TO BE REPRODUCED WITHOUT PERMISSION OF UTI INSTRUMENT CO

ORIG	QC MGR
CHK	PROD MGR
ENG'R	FLD SERVICE MGR
ENG'R MGR	OTHER
MFG MGR	CODE IDENT NO 52654

UTI MILPITAS, CALIFORNIA

TITLE: ASSY, PCB CONTROL

SIZE C | DWG NO 04360 | REV G

SCALE | SHEET 2 OF 2

NEXT ASSY | USED ON

NOTES - UNLESS OTHERWISE SPECIFIED

Figure 12-3C. Control Board, Assembly Drawing (2/2)

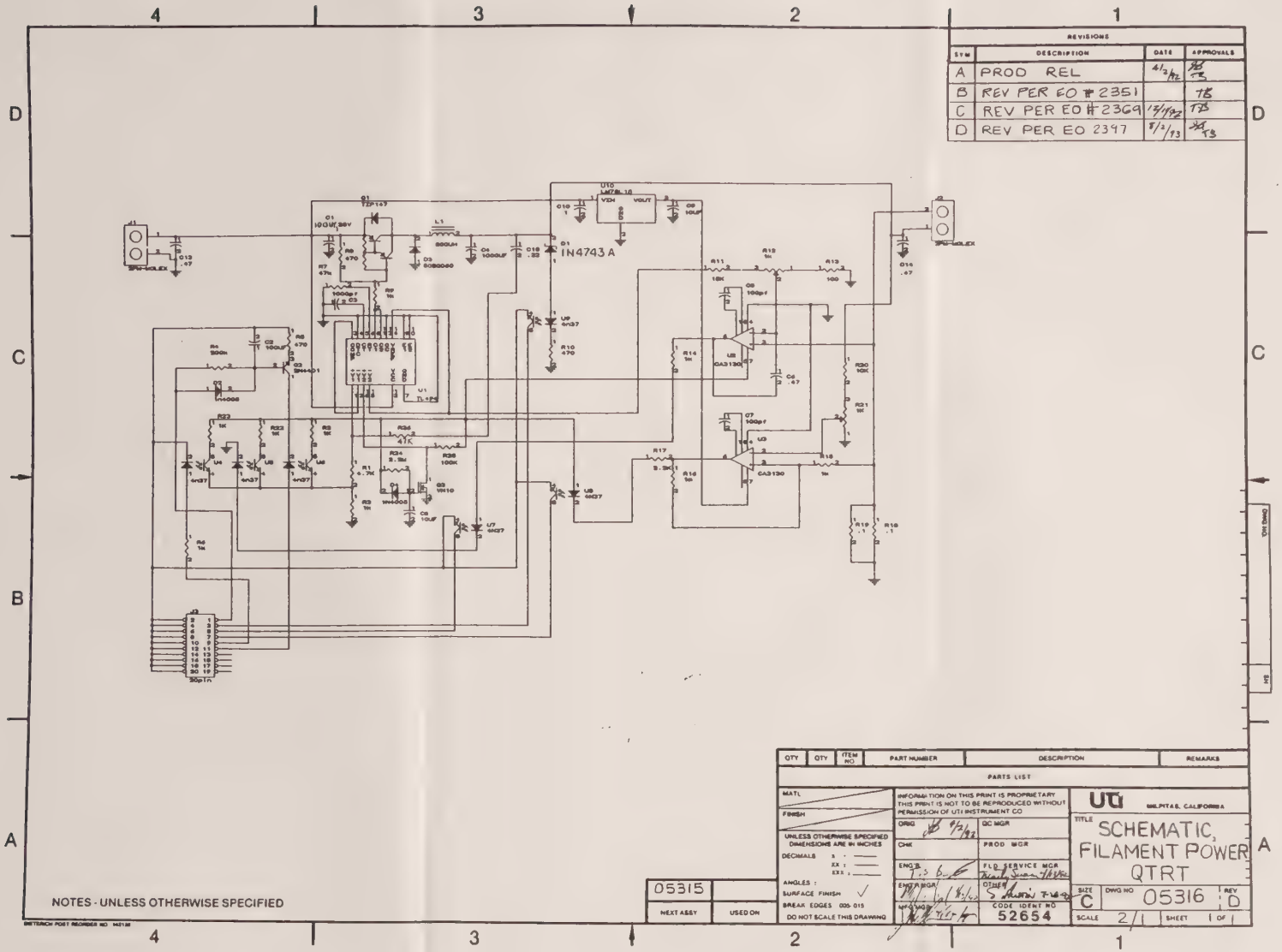


Figure 12-4A. Power Supply - Filament Board, Schematic

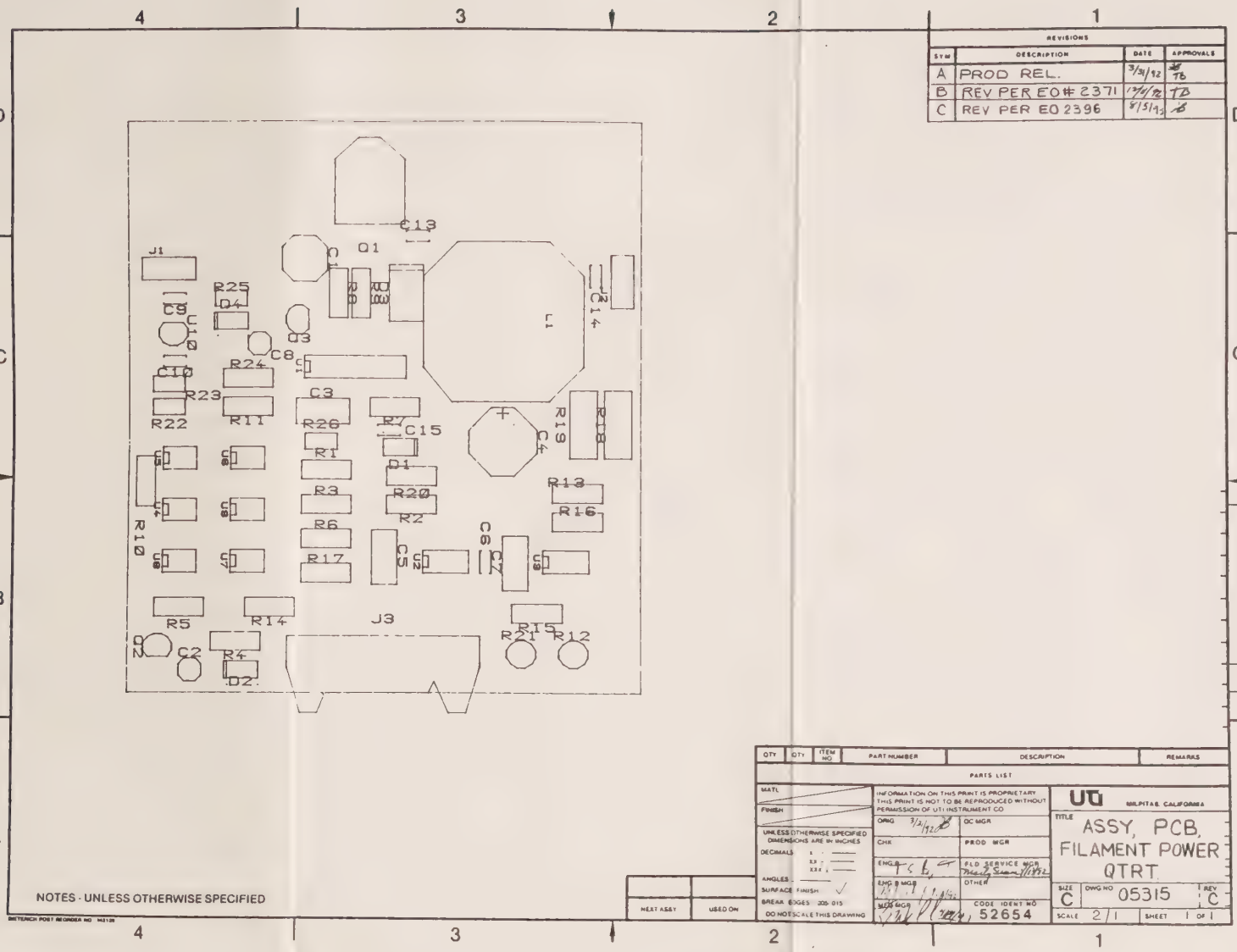


Figure 12-4B. Power Supply - Filament Board, Assembly Drawing

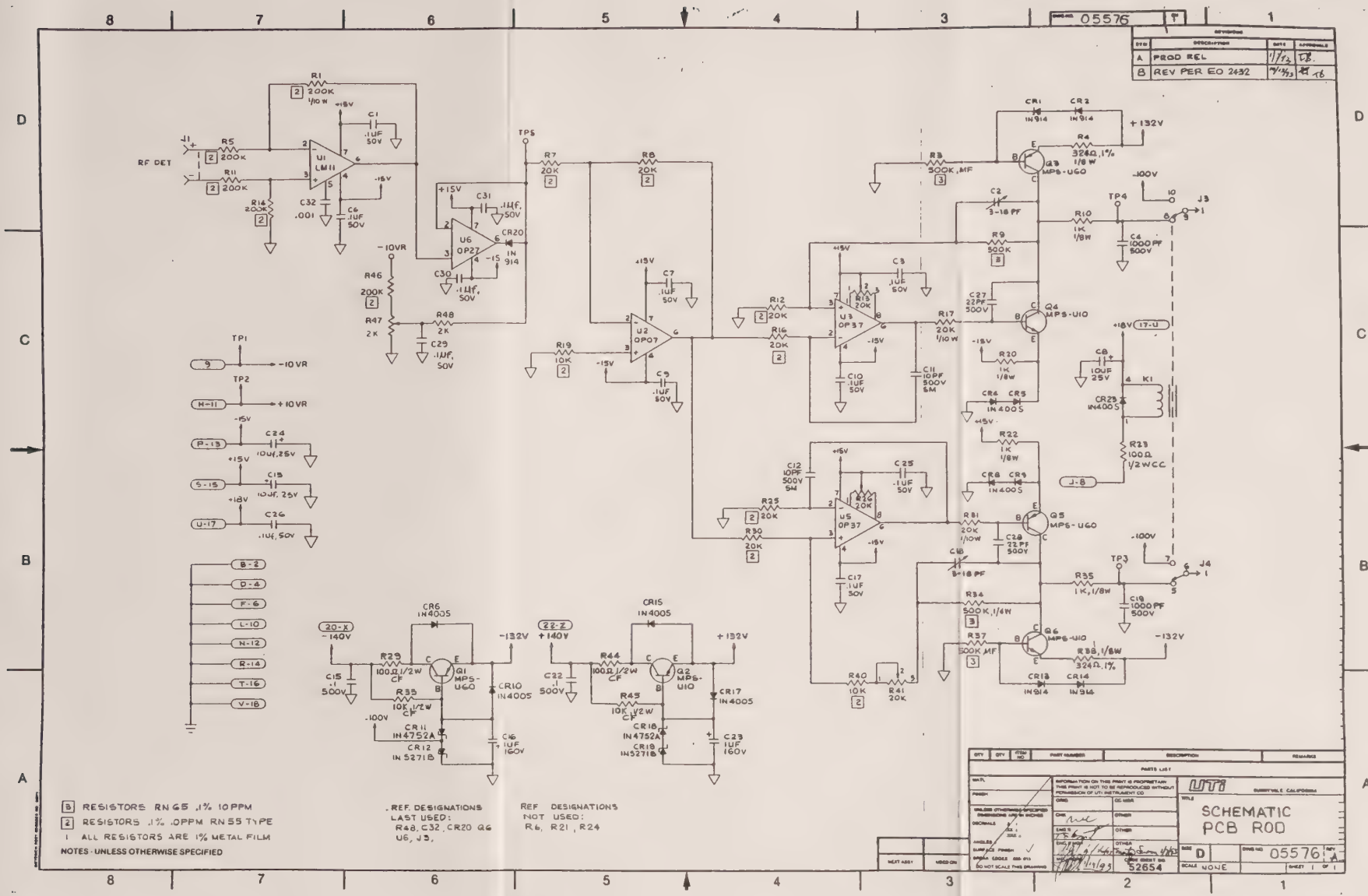


Figure 12-5A. Rod Driver Board, Schematic

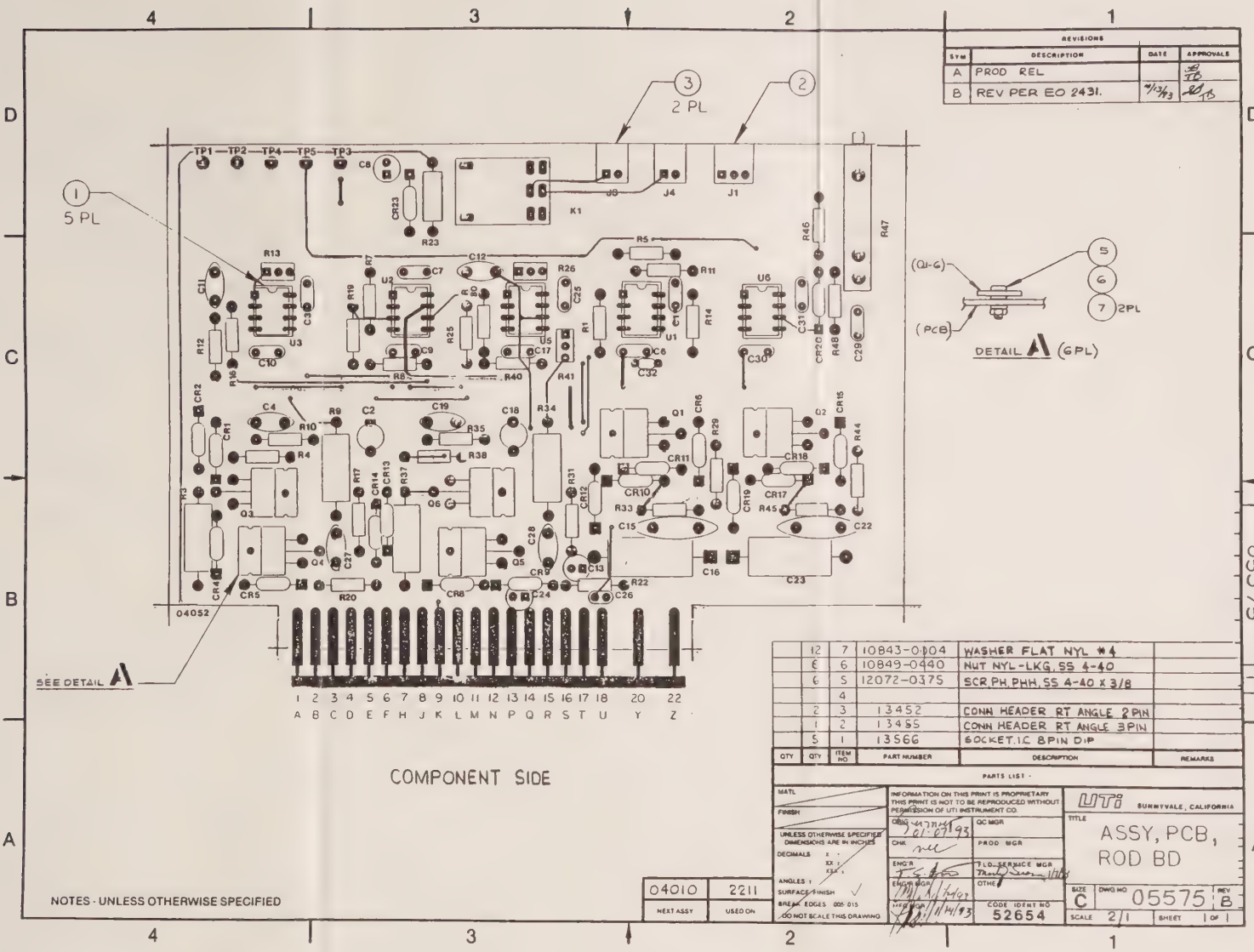

REVISIONS
SYM | DESCRIPTION | DATE | APPROVALS
A | PROD REL
B | REV PER EO 2431. | 9/13/93
2 PL
3
5 PL
1
DETAIL A (6PL)
SEE DETAIL A
04052
COMPONENT SIDE
NOTES - UNLESS OTHERWISE SPECIFIED
PARTS LIST
QTY | QTY | ITEM NO | PART NUMBER | DESCRIPTION | REMARKS
12 | 7 | | 10843-0004 | WASHER FLAT NYL #4
6 | 6 | | 10849-0440 | NUT NYL-LKG, SS 4-40
6 | 5 | | 12072-0375 | SCR PH PHH SS 4-40 X 3/8
4
2 | 3 | | 13452 | CONN HEADER RT ANGLE 2PIN
1 | 2 | | 13455 | CONN HEADER RT ANGLE 3PIN
5 | 1 | | 13566 | SOCKET IC 8PIN DIP
04010 | 2211
NEXT ASSY | USED ON
INFORMATION ON THIS PRINT IS PROPRIETARY
QC MGR
PROD MGR
ENG'R
FLD SERVICE MGR
OTHER
CODE IDENT NO 52654
UTI SUNNYVALE, CALIFORNIA
TITLE
ASSY, PCB, ROD BD
SIZE C | DWG NO 05575 | REV B
SCALE 2/1 | SHEET 1 OF 1

Figure 12-5B. Rod Driver Board, Assembly Drawing

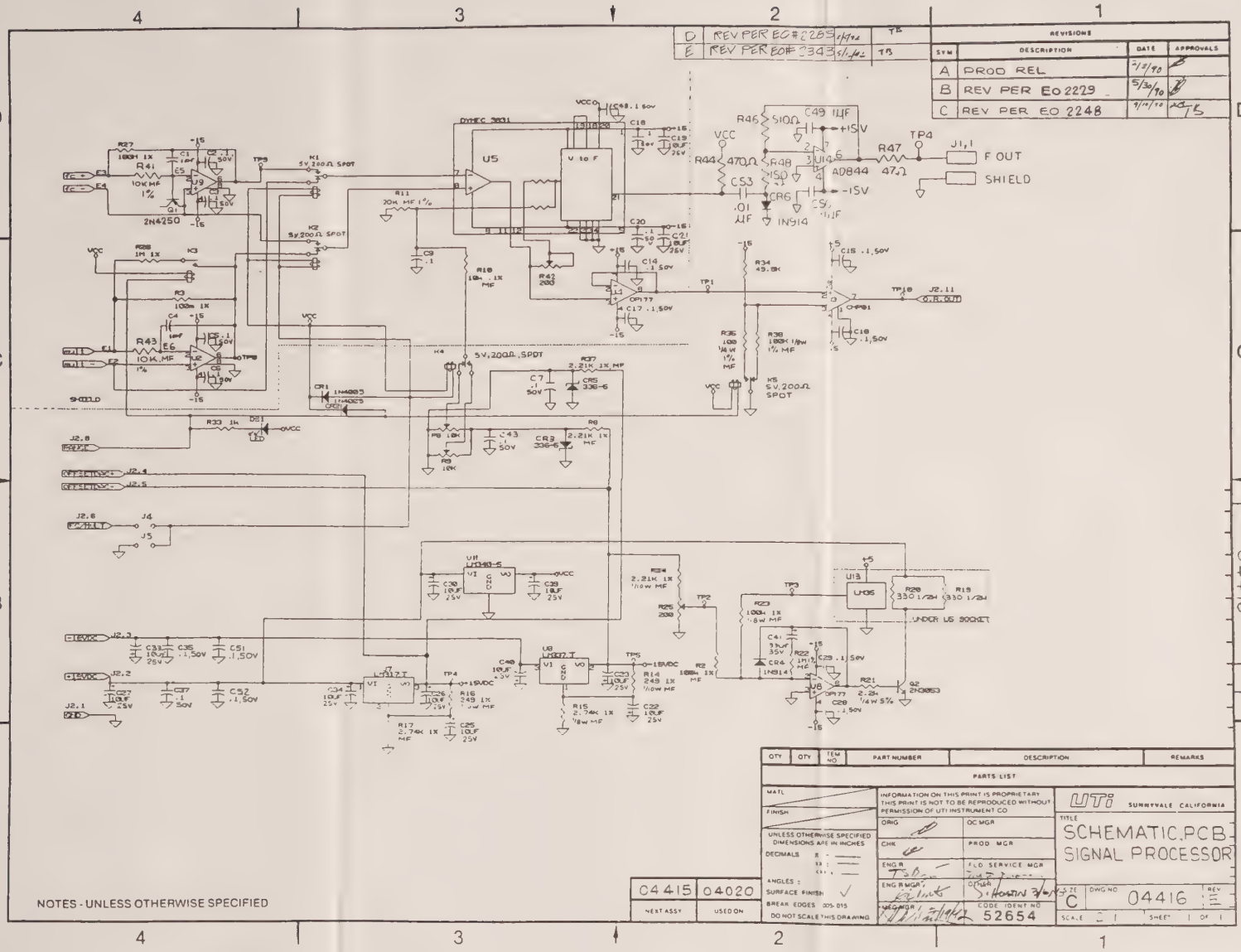


Figure 12-6A. Signal Processor Board, Schematic

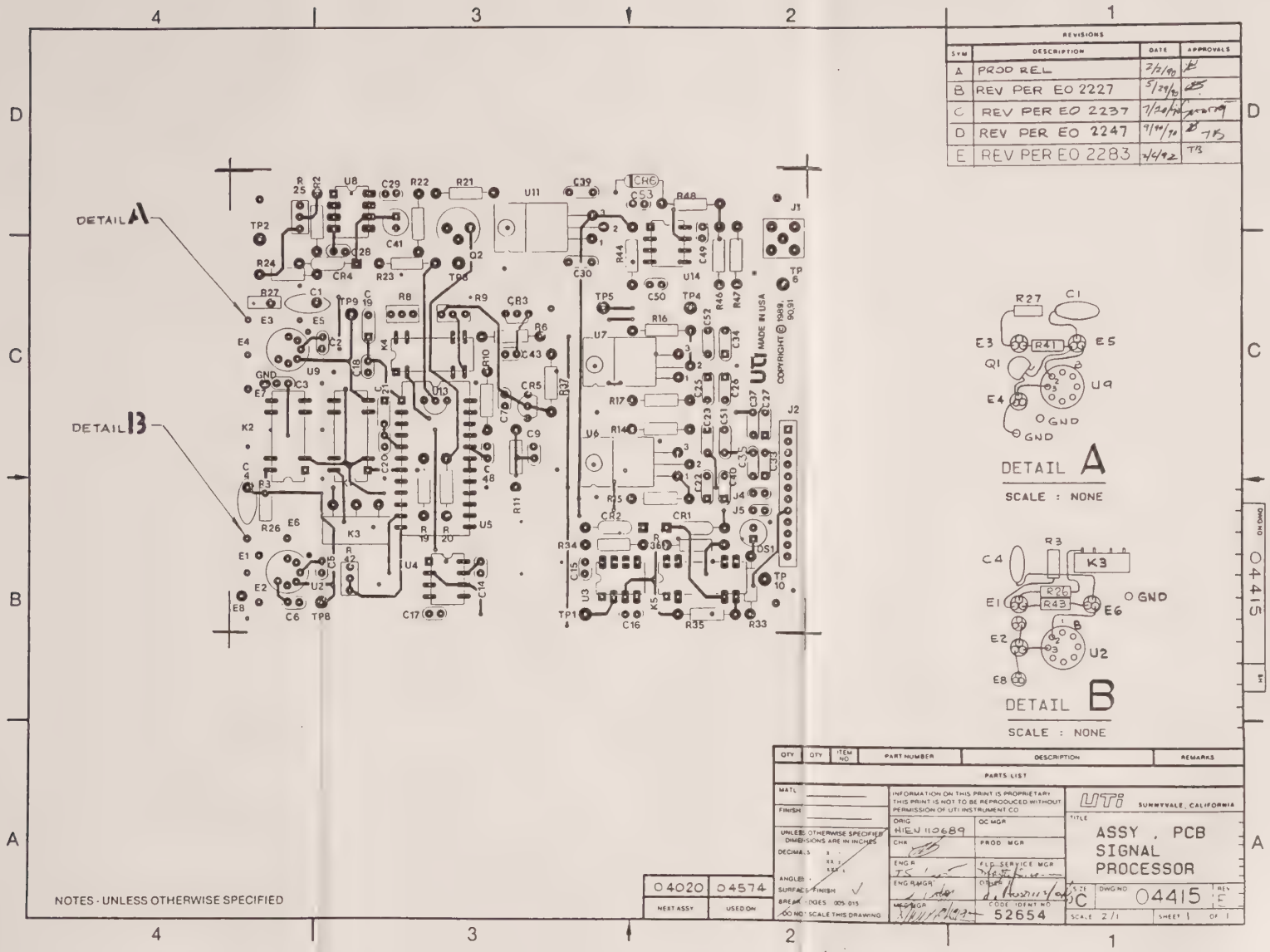

REVISIONS
SYM | DESCRIPTION | DATE | APPROVALS
A | PROD REL | 7/2/91
B | REV PER EO 2227 | 5/29/92
C | REV PER EO 2237 | 7/20/92
D | REV PER EO 2247 | 9/10/92
E | REV PER EO 2283 | 1/4/93
DETAIL A
DETAIL B
SCALE : NONE
NOTES - UNLESS OTHERWISE SPECIFIED
PARTS LIST
QTY | QTY | ITEM NO | PART NUMBER | DESCRIPTION | REMARKS
ASSY , PCB SIGNAL PROCESSOR
SUNNYVALE, CALIFORNIA
DWG NO 04415
SCALE 2/1
SHEET 1 OF 1
04020 NEXT ASSY
04574 USED ON
52654

Figure 12-6B. Signal Processor Board, Assembly Drawing (1/2)

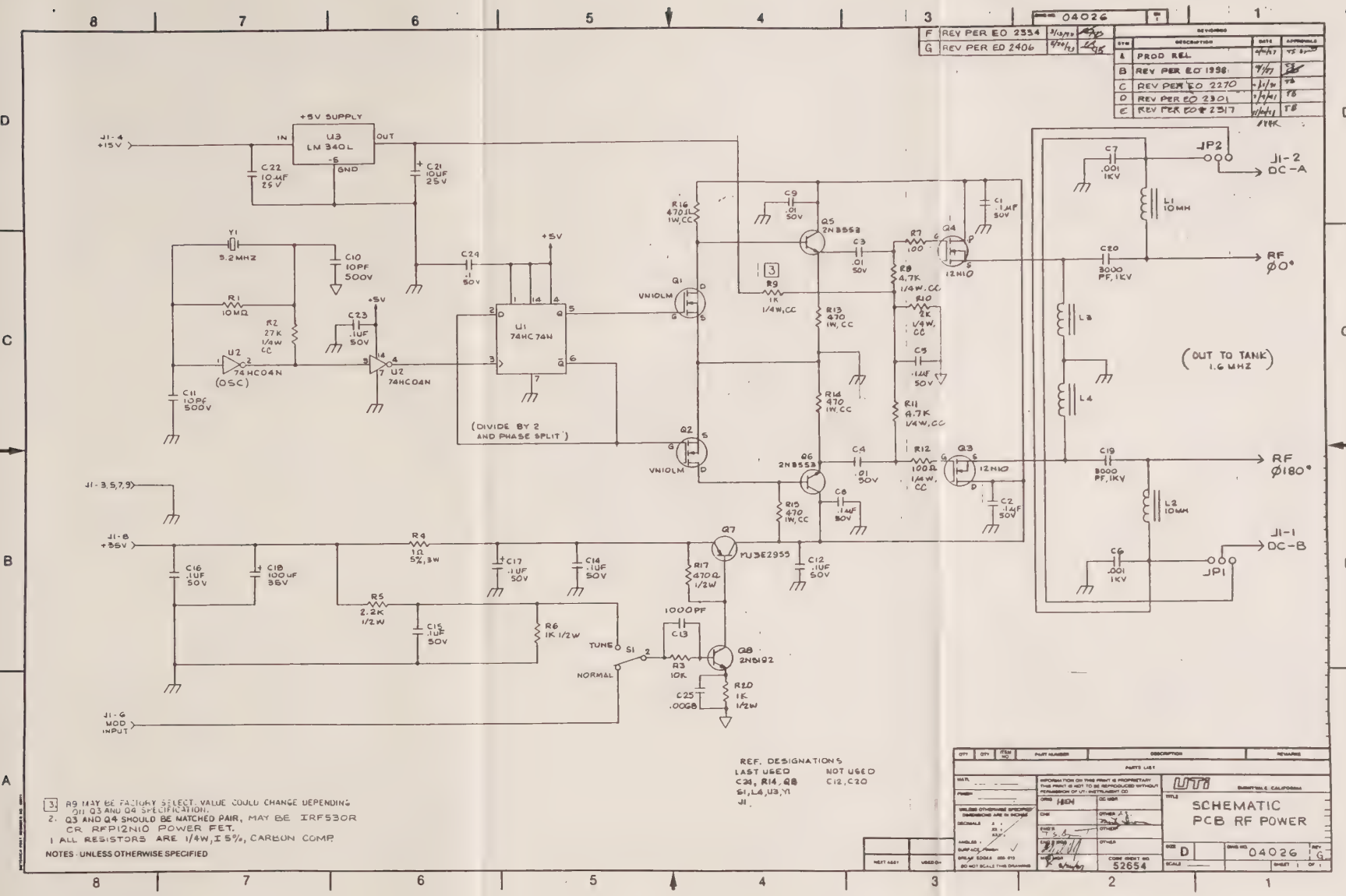


Figure 12-7A. RF Power Board, Schematic

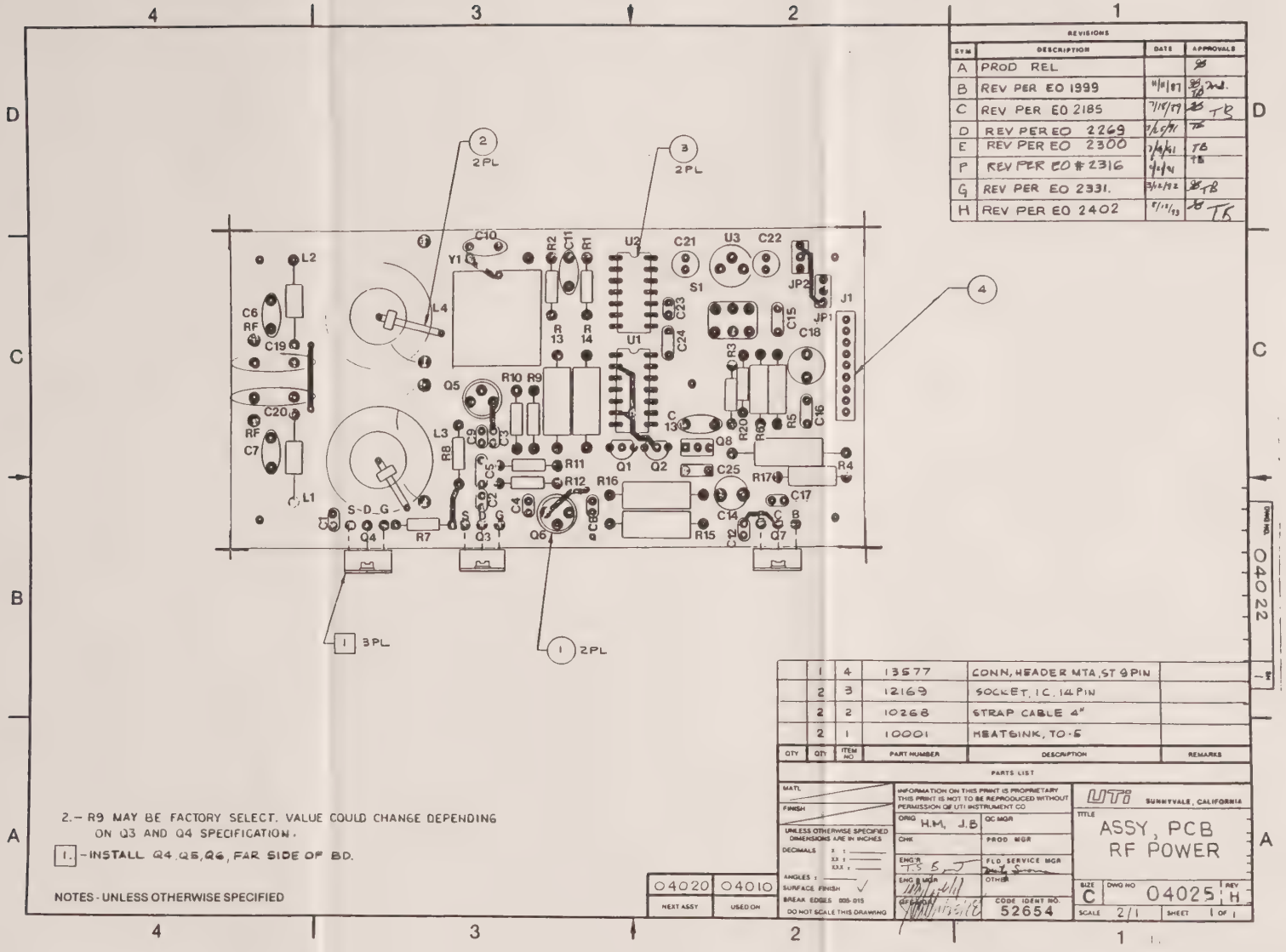

REVISIONS
SYM | DESCRIPTION | DATE | APPROVALS
A | PROD REL | | JB
B | REV PER EO 1999 | 11/8/87 | JB JW
C | REV PER EO 2185 | 7/15/89 | JB TB
D | REV PER EO 2269 | 7/6/91 | TB
E | REV PER EO 2300 | 2/4/92 | TB
P | REV PER EO # 2316 | 4-4-92 | TB
G | REV PER EO 2331. | 8/12/92 | JB TB
H | REV PER EO 2402 | 8/13/93 | JB TB
2 PL
3 PL
4
1 3PL
1 2PL
C10 Y1 R2 C11 R1 U2 C21 U3 C22 JP2 J1
L2 C6 RF C19 S1 C23 C24 C15 JP1 C18
L4 R13 R14 U1 R3
C20 RF C7 Q5 R10 R9 C13 R20 R5 C16
L3 R8 C3 C5 C2 R11 Q1 Q2 Q8 R6 R4
L1 S-D-G Q4 R7 Q3 R12 R16 C25 R17 C17
C4 C8 Q6 R15 C14 Q7
2.- R9 MAY BE FACTORY SELECT. VALUE COULD CHANGE DEPENDING ON Q3 AND Q4 SPECIFICATION.
1.- INSTALL Q4,Q5,Q6, FAR SIDE OF BD.
NOTES - UNLESS OTHERWISE SPECIFIED
1 | 4 | 13577 | CONN, HEADER MTA, ST 9 PIN
2 | 3 | 12169 | SOCKET, I.C. 14 PIN
2 | 2 | 10268 | STRAP CABLE 4"
2 | 1 | 10001 | HEATSINK, TO-5
QTY | QTY | ITEM NO | PART NUMBER | DESCRIPTION | REMARKS
PARTS LIST
MATL
FINISH
INFORMATION ON THIS PRINT IS PROPRIETARY THIS PRINT IS NOT TO BE REPRODUCED WITHOUT PERMISSION OF UTI INSTRUMENT CO
UTI SUNNYVALE, CALIFORNIA
ORIG H.M. J.B
QC MGR
CHK
PROD MGR
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMALS
ENGR T.S. S.J.
FLD SERVICE MGR
ANGLES
SURFACE FINISH
ENG MGR
OTHER
BREAK EDGES .005-.015
DO NOT SCALE THIS DRAWING
DESIGN
CODE IDENT NO. 52654
TITLE ASSY, PCB RF POWER
SIZE C
DWG NO 04025
REV H
SCALE 2/1
SHEET 1 OF 1
04020 NEXT ASSY
04010 USED ON
DWG NO 04022
REV H

Figure 12-7B. RF Power Board, Assembly Drawing

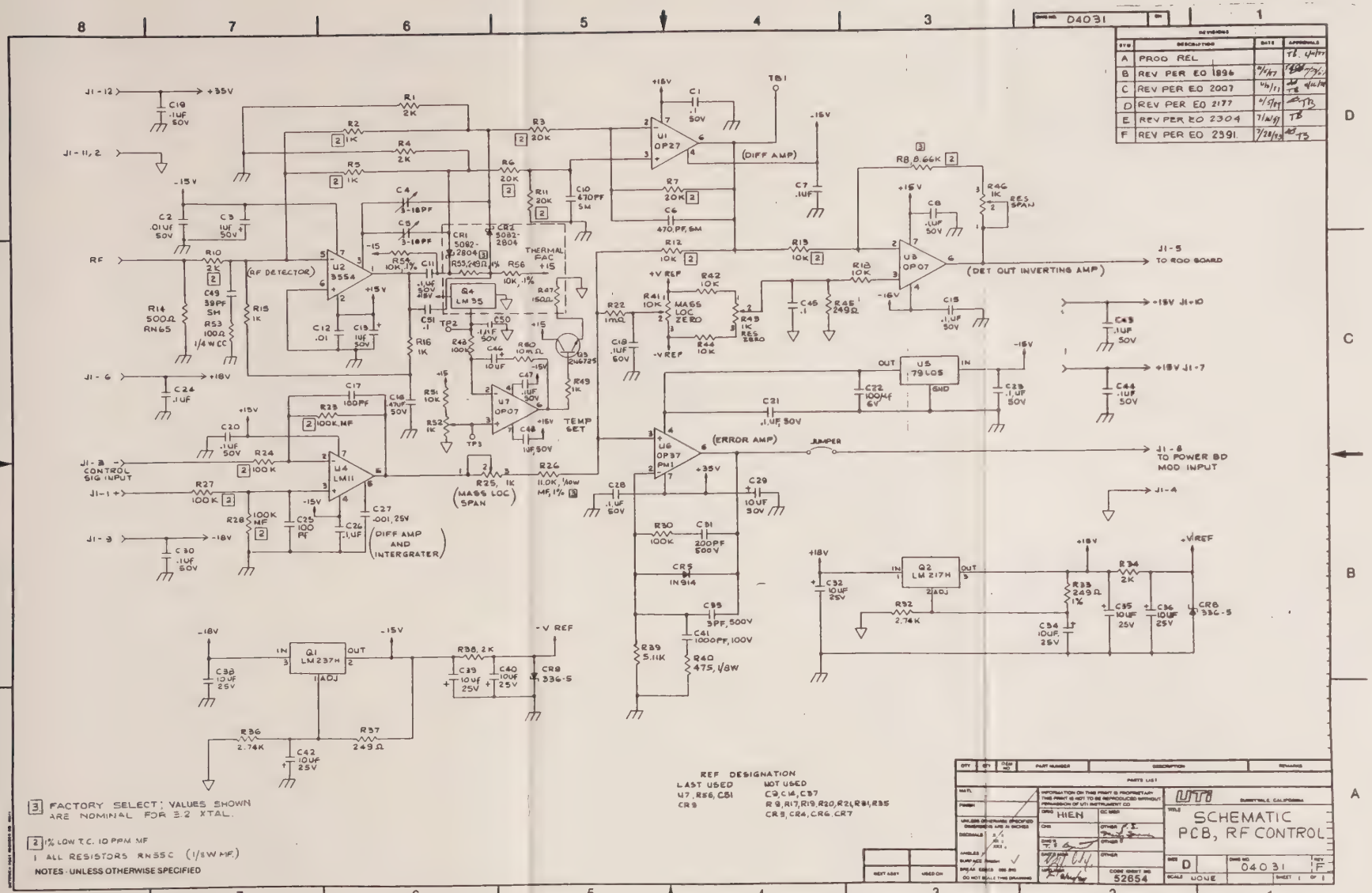


Figure 12-8A. RF Control Board, Schematic

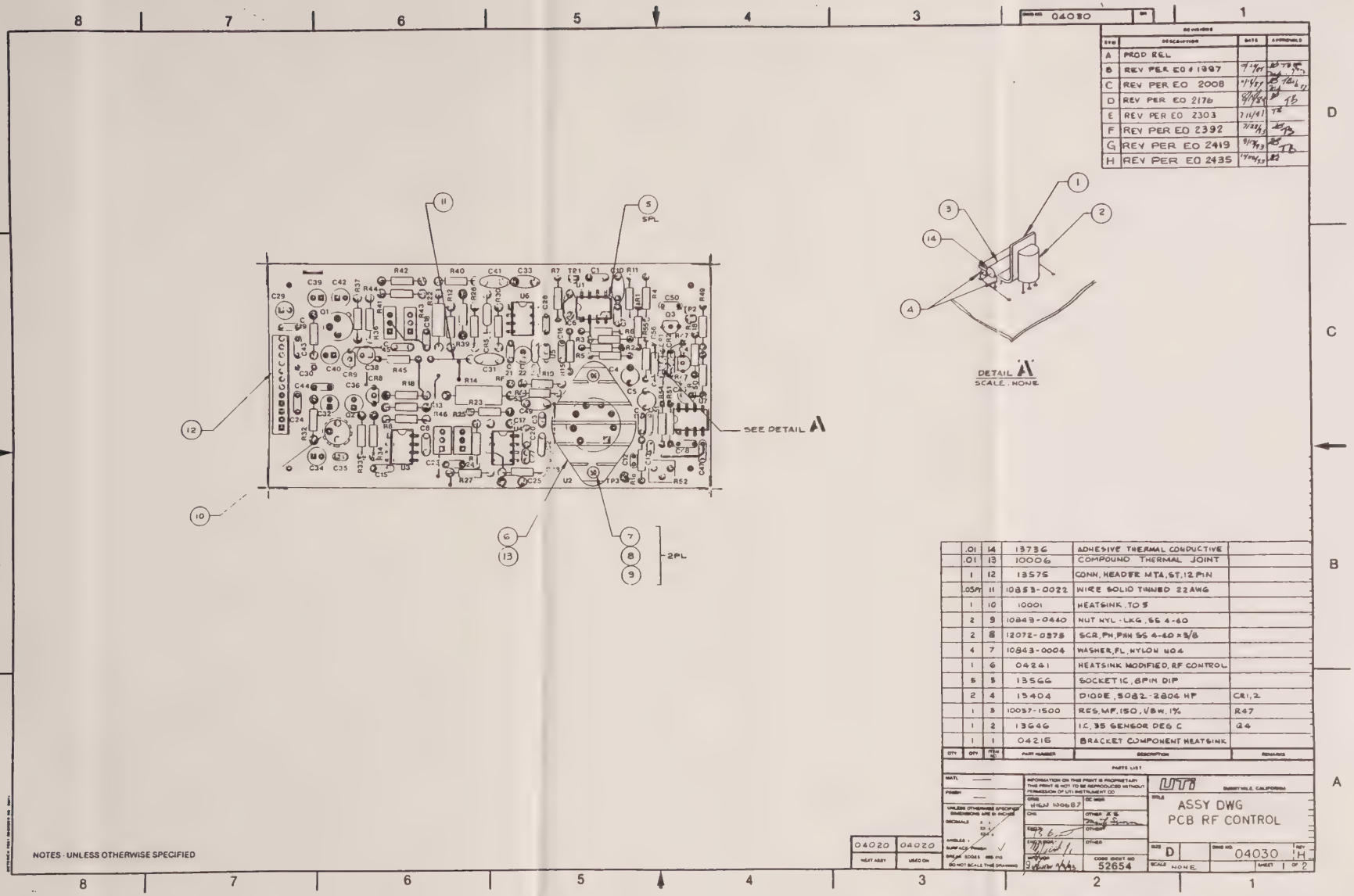
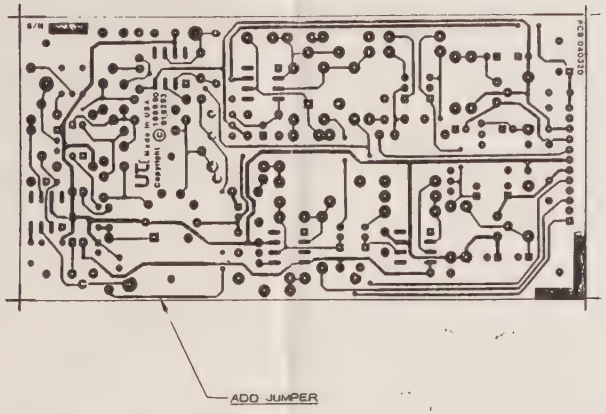

04030
REVISIONS
LTR DESCRIPTION DATE APPROVED
A PROD REL
B REV PER EO # 1997 7-7-91
C REV PER EO 2008 7-17-91
D REV PER EO 2176 5-19-92
E REV PER EO 2303 7-14-93
F REV PER EO 2392 7-22-93
G REV PER EO 2419 8-3-93
H REV PER EO 2435 12-14-93
DETAIL A
SCALE: NONE
SEE DETAIL A
2PL
NOTES: UNLESS OTHERWISE SPECIFIED
QTY QTY ITEM NO PART NUMBER DESCRIPTION REMARKS
.01 14 13736 ADHESIVE THERMAL CONDUCTIVE
.01 13 10006 COMPOUND THERMAL JOINT
1 12 13575 CONN, HEADER MTA, ST, 12 PIN
.05Ft 11 10853-0022 WIRE SOLID TINNED 22AWG
1 10 10001 HEATSINK, TO 5
2 9 10843-0440 NUT NYL-LKG, SS 4-40
2 8 12072-0378 SCR, PH, PAN SS 4-40 X 3/8
4 7 10843-0004 WASHER, FL, NYLON #04
1 6 04241 HEATSINK MODIFIED, RF CONTROL
5 5 13566 SOCKET IC, 8PIN DIP
2 4 13404 DIODE, 5082-2804 HP CR1,2
1 3 10037-1500 RES, MF, 150, 1/8W, 1% R47
1 2 13646 I.C. 35 SENSOR DEG C Q4
1 1 04216 BRACKET COMPONENT HEATSINK
PARTS LIST
UTI
ASSY DWG
PCB RF CONTROL
SIZE D
DWG NO 04030
REV H
SCALE NONE
SHEET 1 OF 2
04020 NEXT ASSY
04020 USED ON
CODE IDENT NO 52654

Figure 12-8B. RF Control Board, Assembly Drawing



NOTES - UNLESS OTHERWISE SPECIFIED

QTY	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REMARKS
			PARTS LIST		

UTI San Jose, California

ASSY, DWG
PCB RF CONTROL

SIZE D | DWG NO 04030 | REV H | SCALE 2/1 | SHEET 2 OF 2

CODE IDENT NO. 52654

Figure 12-8C. RF Control Board, Assembly Drawing (2/2)

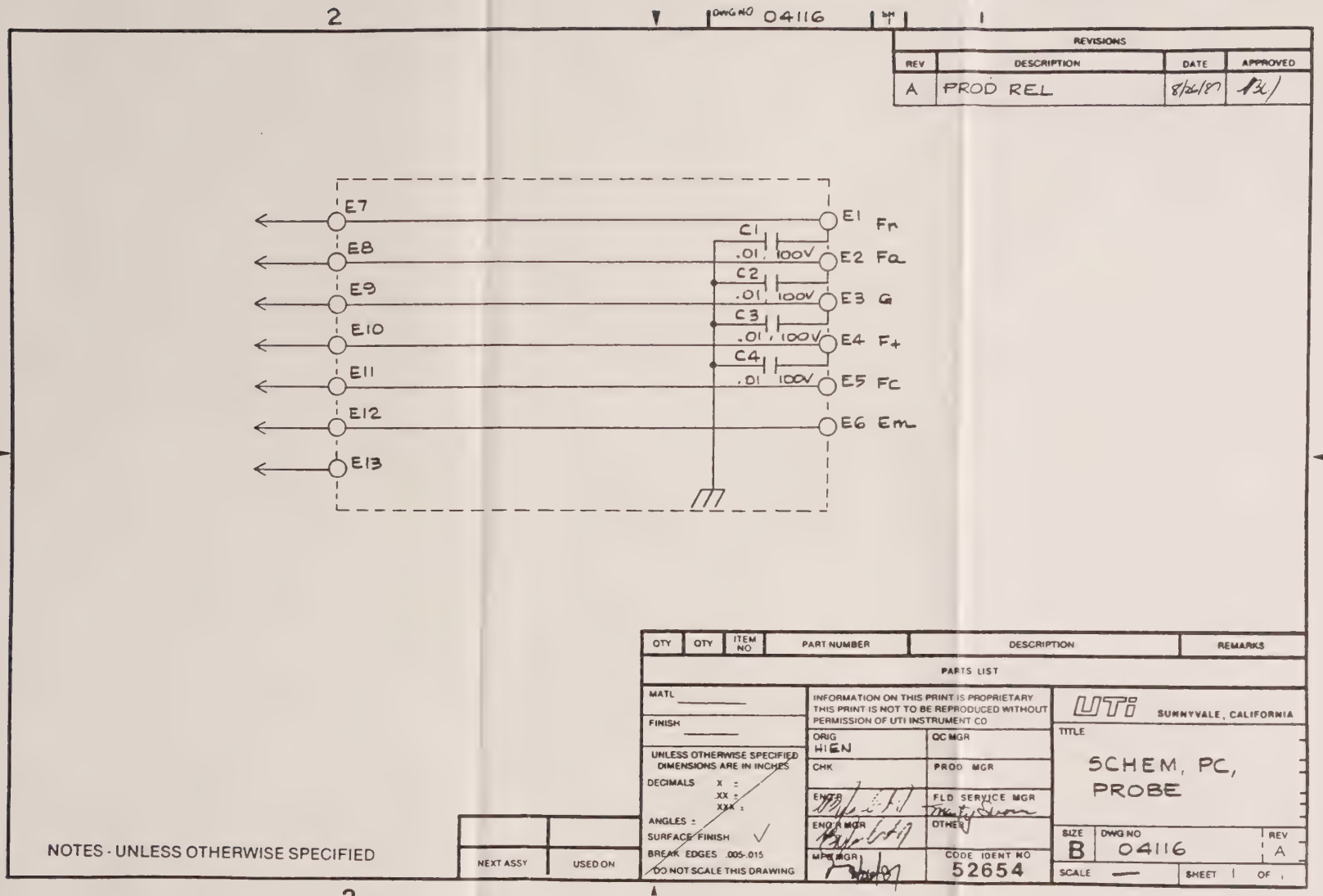


Figure 12-9A. Probe Flange PCB, Schematic

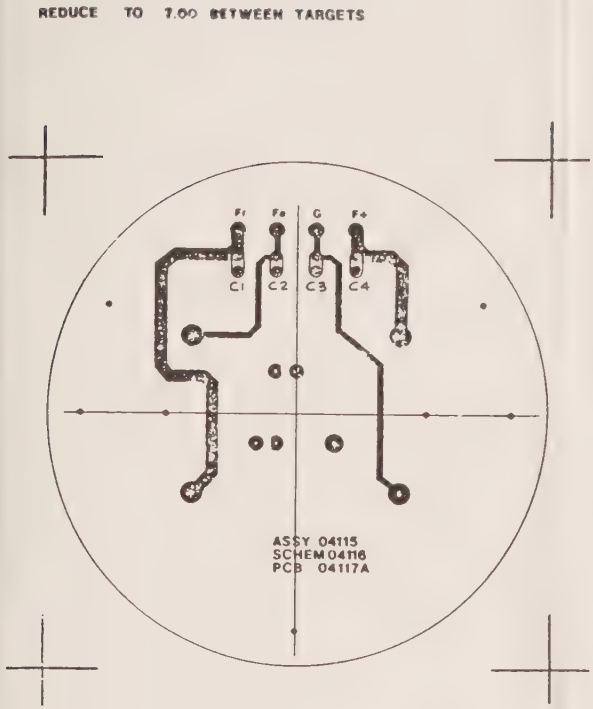


Figure 12-9B. Probe Flange PCB, Assembly Drawing

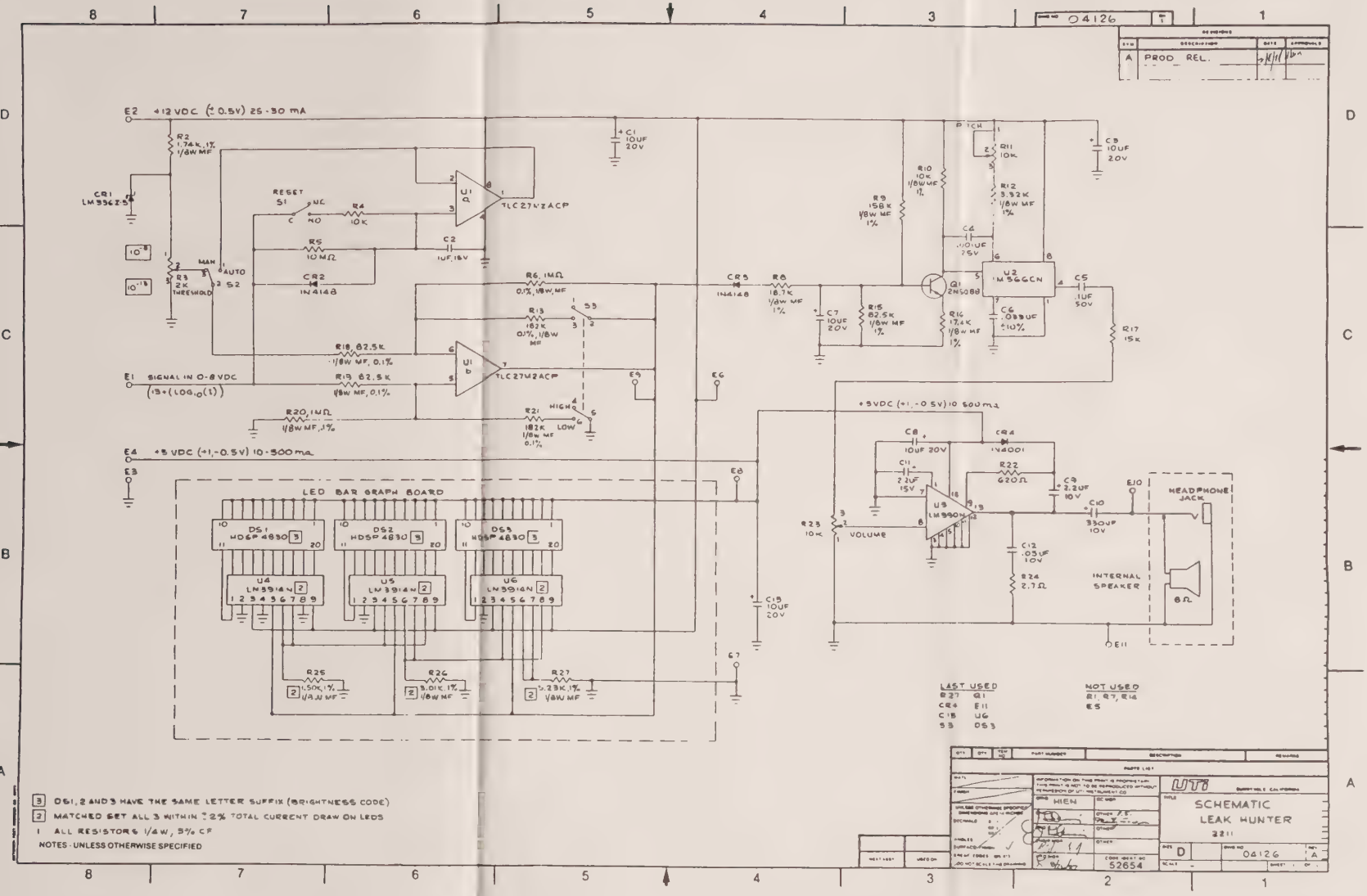


Figure 12-10A. Leak Hunter Schematic

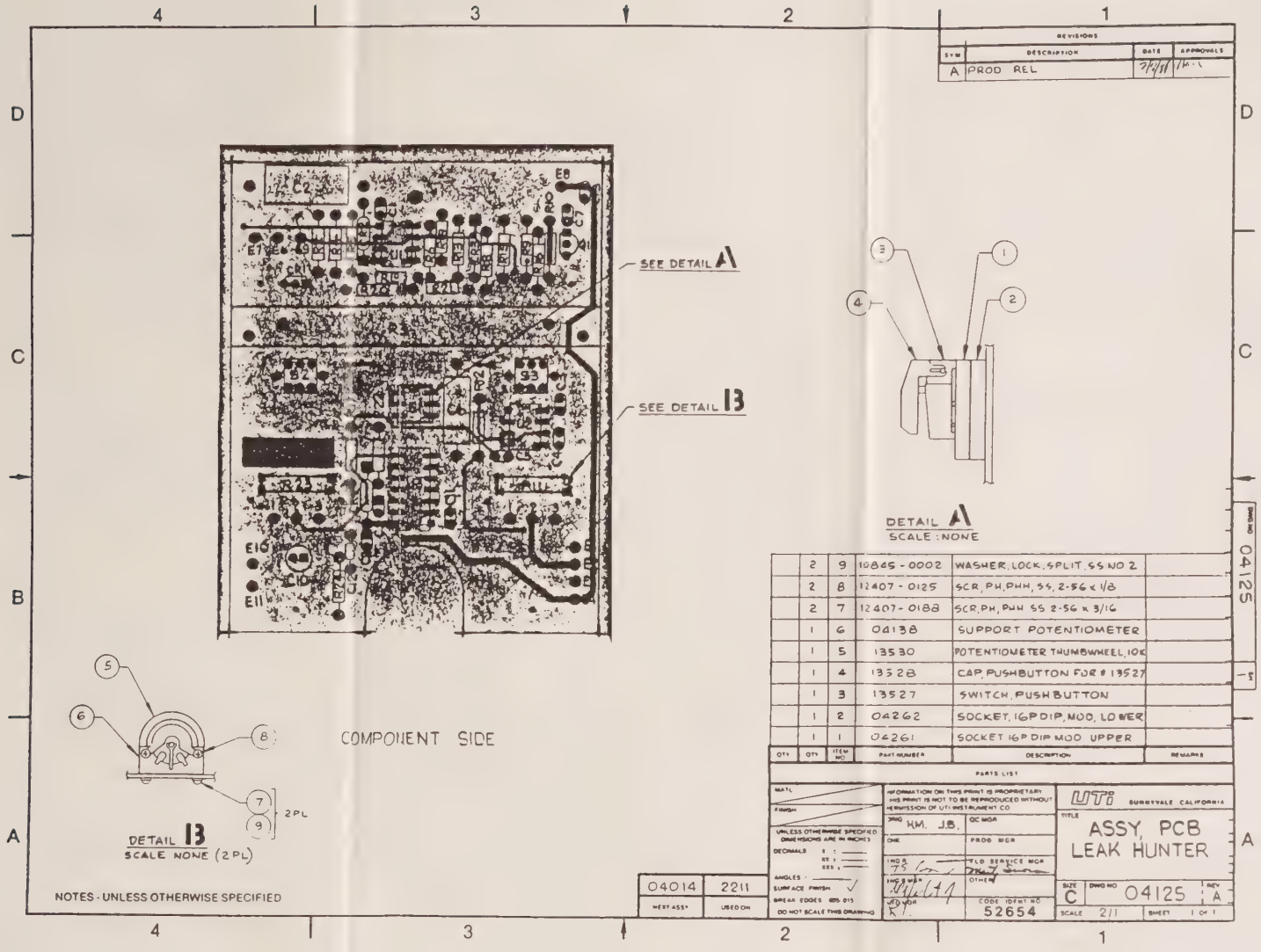

REVISIONS
SYM DESCRIPTION DATE APPROVALS
A PROD REL 7/1/11
SEE DETAIL A
SEE DETAIL B
DETAIL A
SCALE : NONE
COMPONENT SIDE
DETAIL B
SCALE NONE (2PL)
2PL
NOTES - UNLESS OTHERWISE SPECIFIED
QTY QTY ITEM NO PART NUMBER DESCRIPTION REMARKS
2 9 10845 - 0002 WASHER, LOCK, SPLIT, SS NO 2
2 8 12407 - 0125 SCR, PH, PHH, SS, 2-56 x 1/8
2 7 12407 - 0188 SCR, PH, PHH SS 2-56 x 3/16
1 6 04138 SUPPORT POTENTIOMETER
1 5 13530 POTENTIOMETER THUMBWHEEL, 10K
1 4 13528 CAP, PUSHBUTTON FOR # 13527
1 3 13527 SWITCH, PUSHBUTTON
1 2 04262 SOCKET, 16P DIP, MOD, LOWER
1 1 04261 SOCKET 16P DIP MOD UPPER
PARTS LIST
UTI SUNNYVALE, CALIFORNIA
TITLE ASSY, PCB LEAK HUNTER
DWG NO 04125
SIZE C
REV A
SCALE 2/1
SHEET 1 OF 1
04014 2211
CODE IDENT NO 52654

Figure 12-10B. Leak Hunter, Assembly Drawing

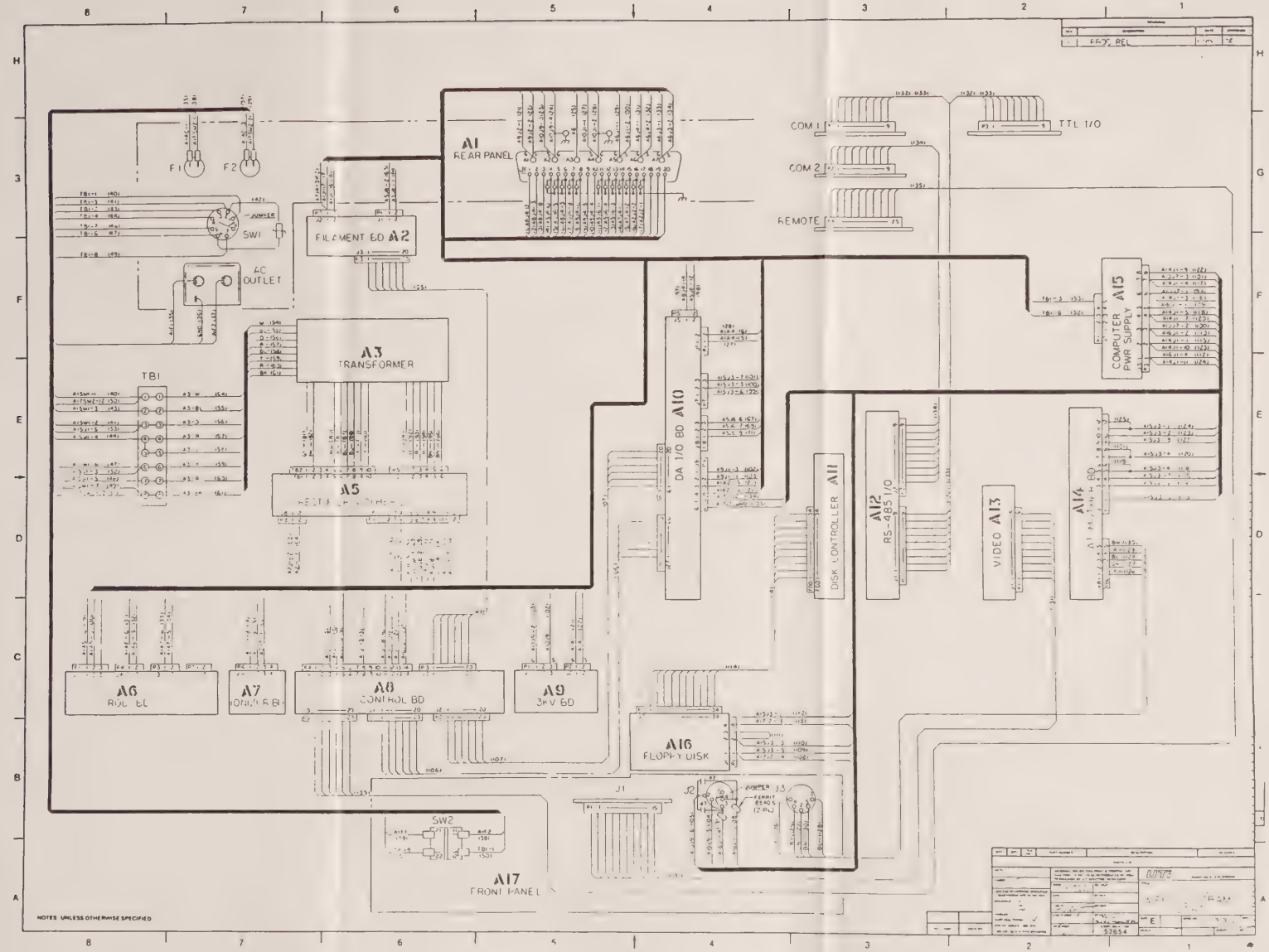


Figure 12-11A. Diagram, Wiring QualiTorr (1/2) QTRT

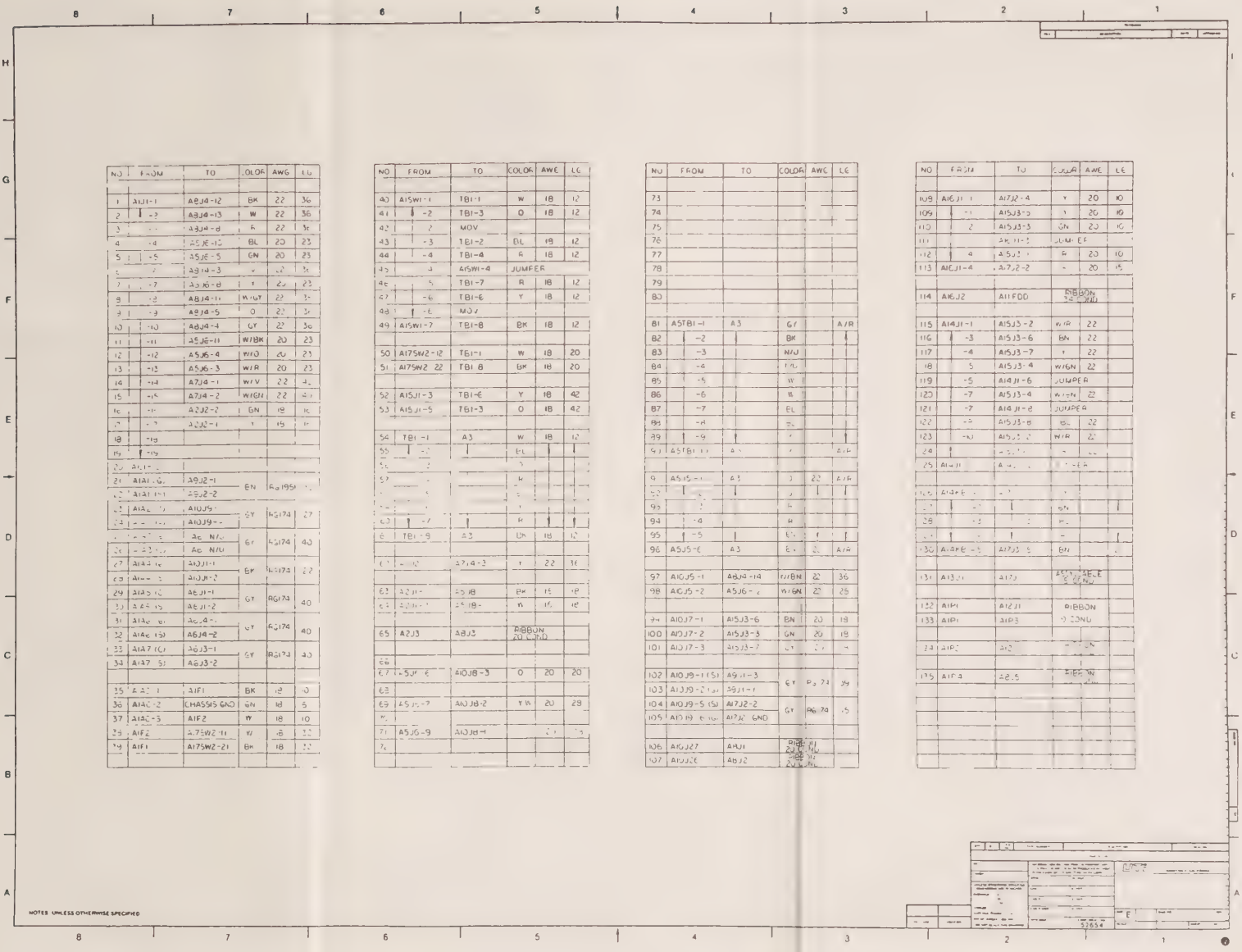


Figure 12-11B. Diagram, Wiring QualiTorr (2/2) QTRT

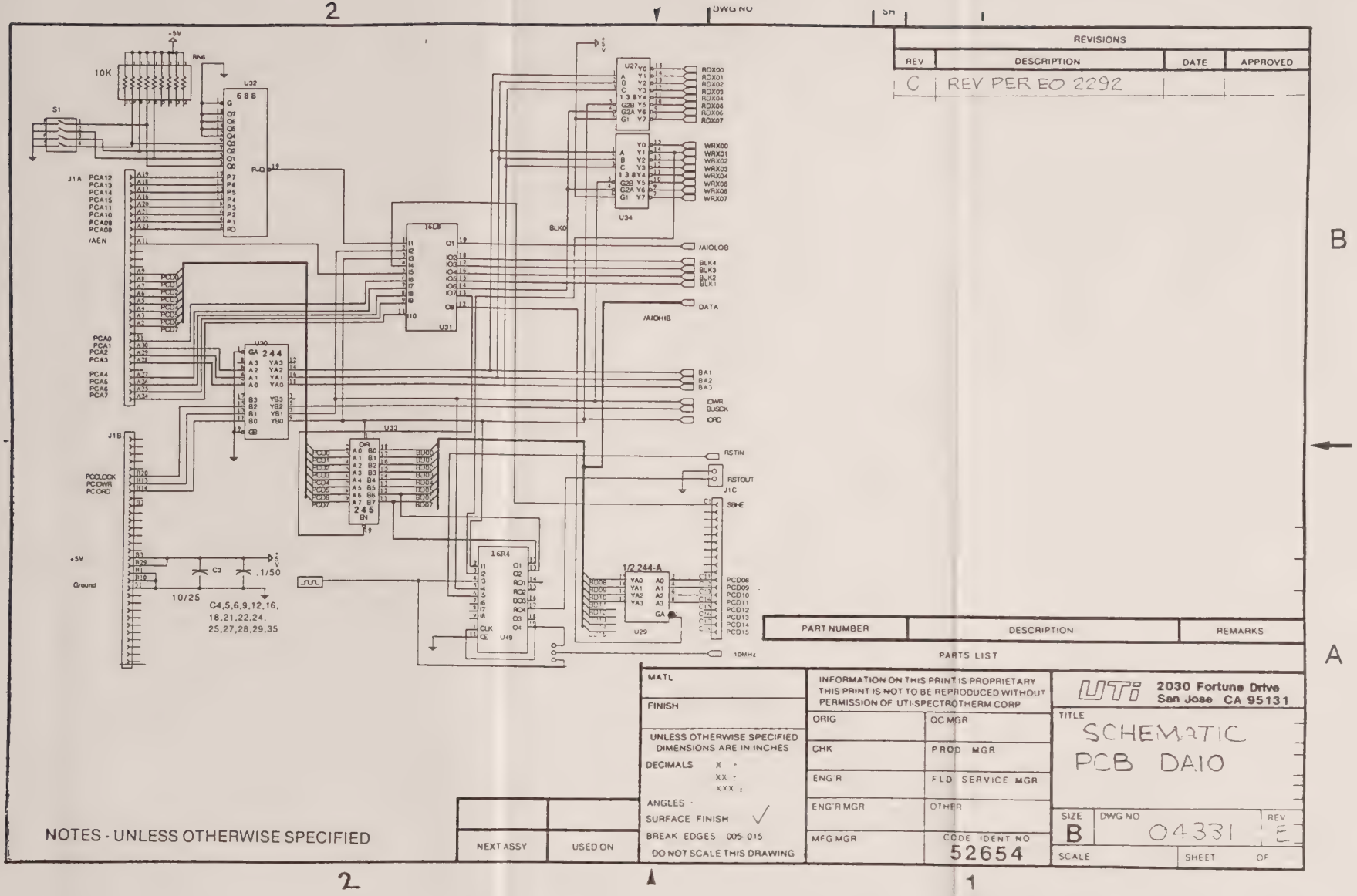


Figure 12-12A. Digital/Analog I/O, Schematic (1/6)

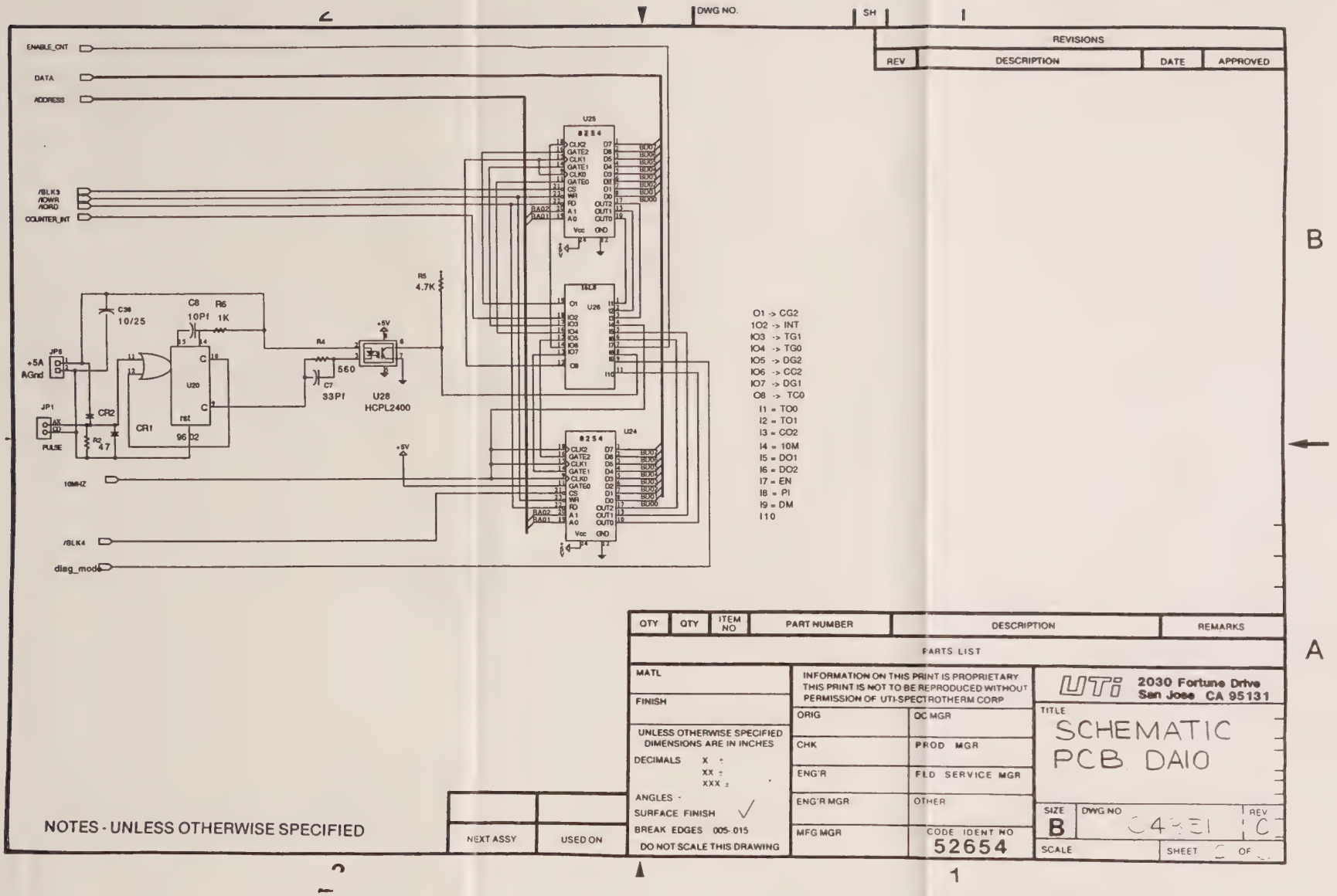


Figure 12-12B. Digital/Analog I/O, Schematic (2/6)

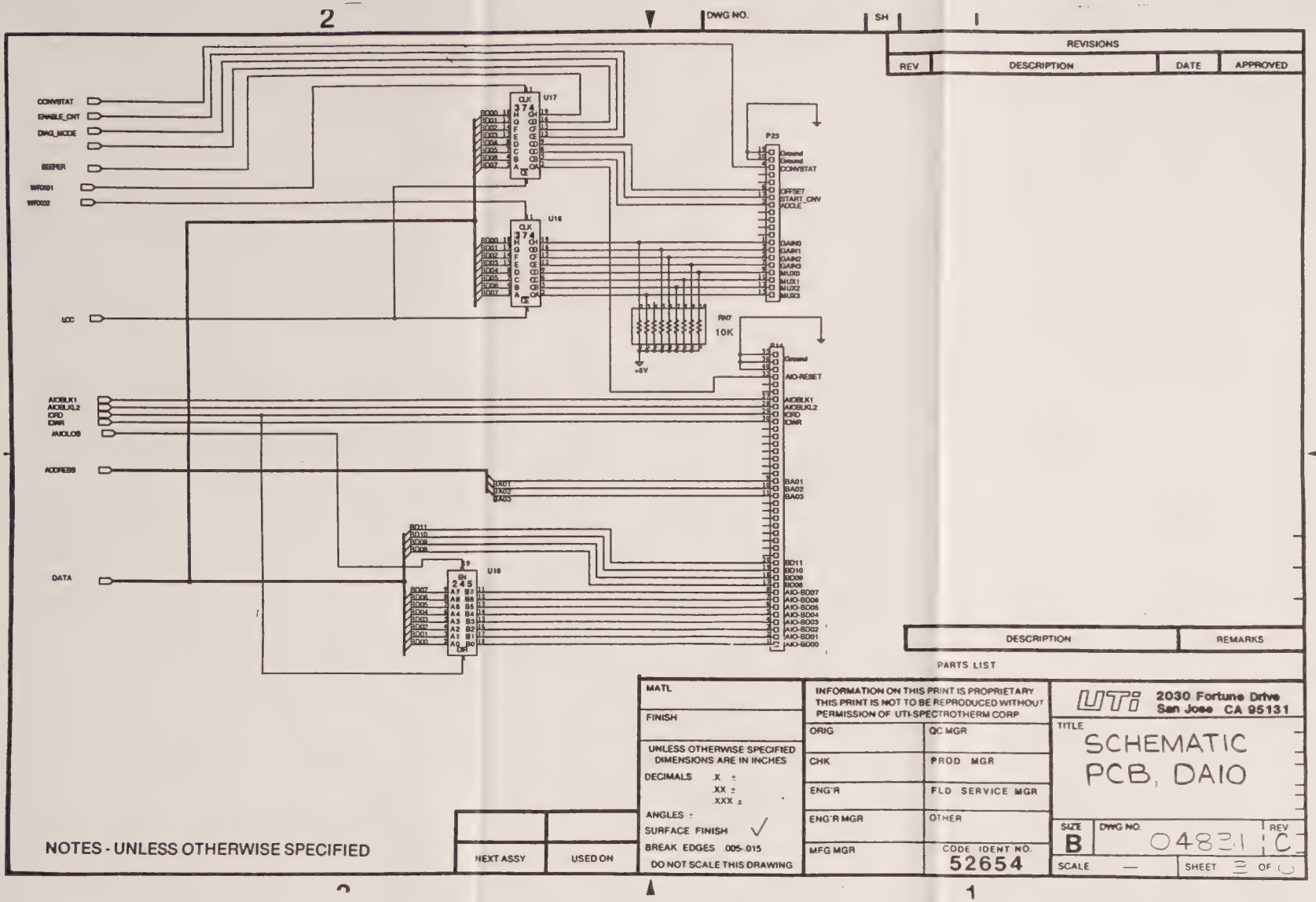


Figure 12-12C. Digital/Analog I/O. Schematic (3/6)

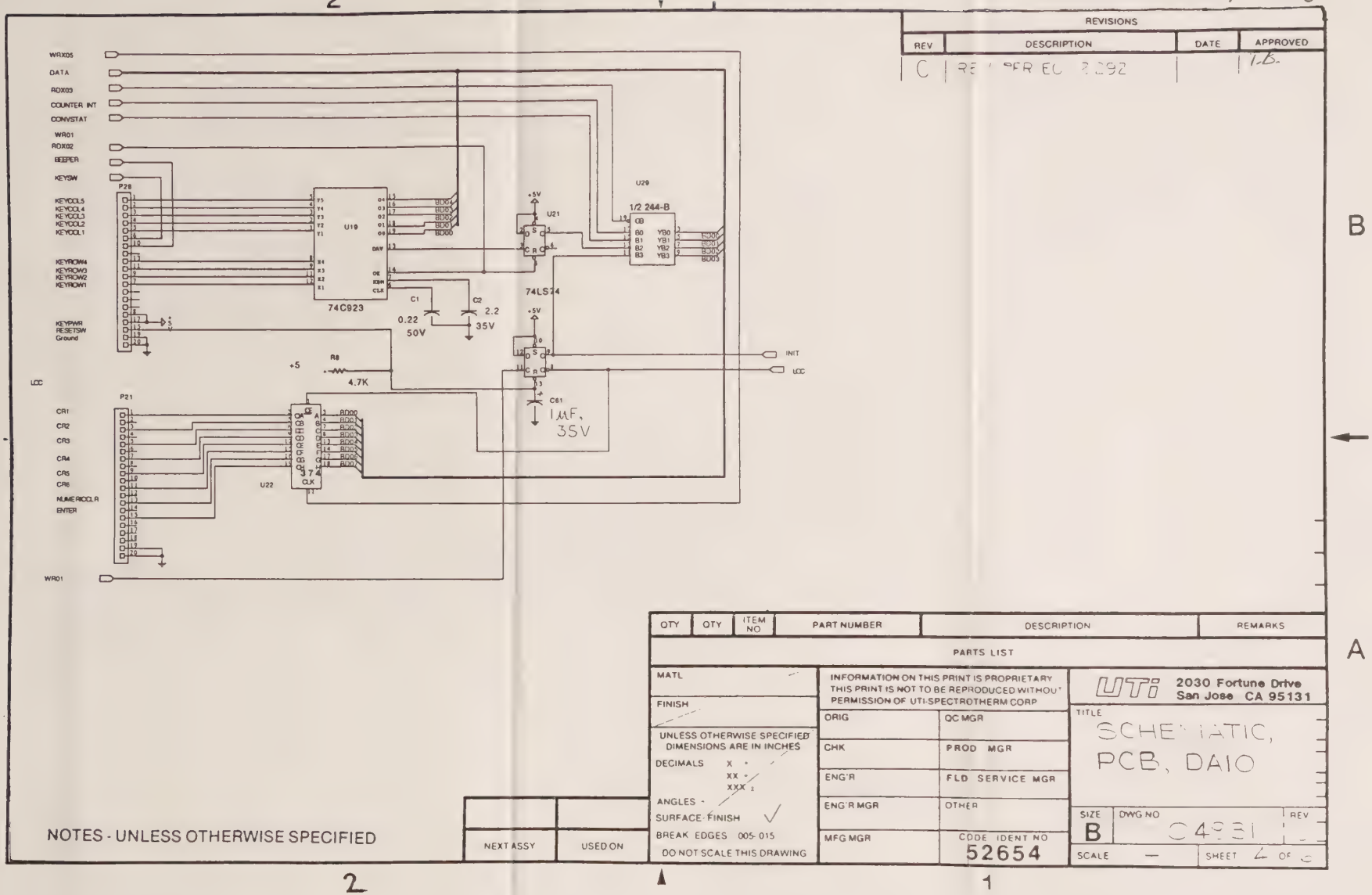


Figure 12-12D. Digital/Analog I/O, Schematic (4/6)

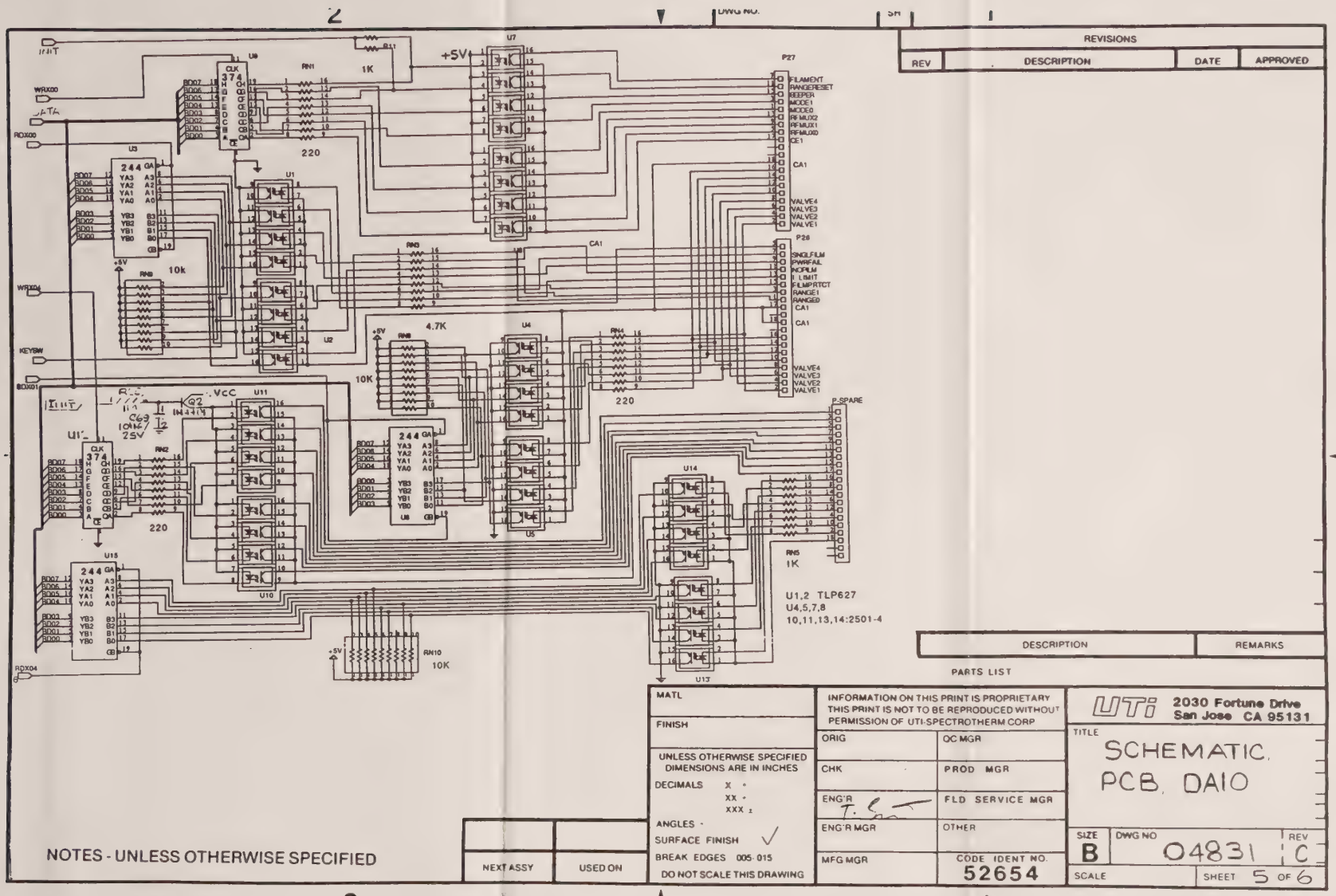


Figure 12-12E. Digital/Analog I/O, Schematic (5/6)

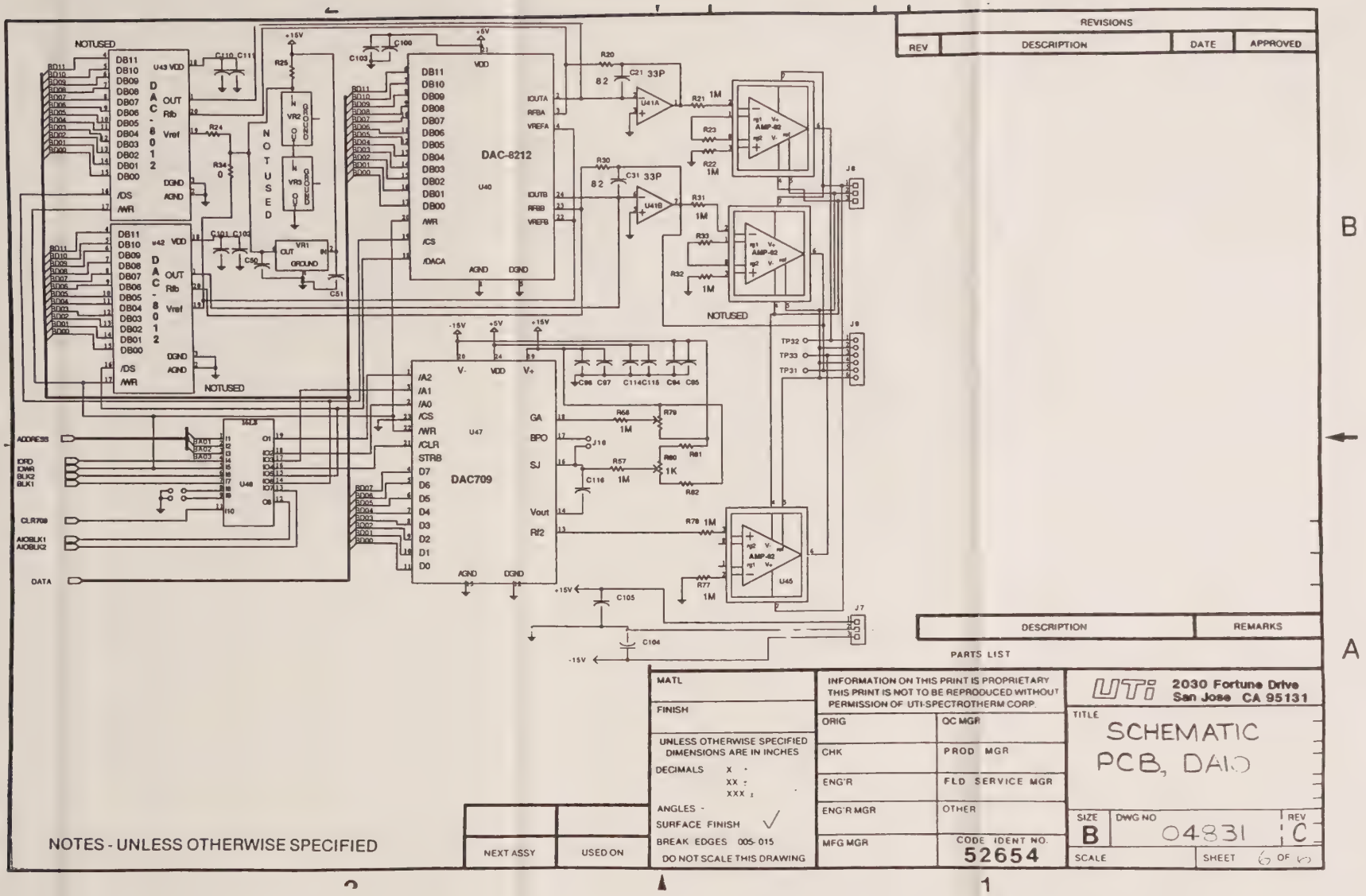
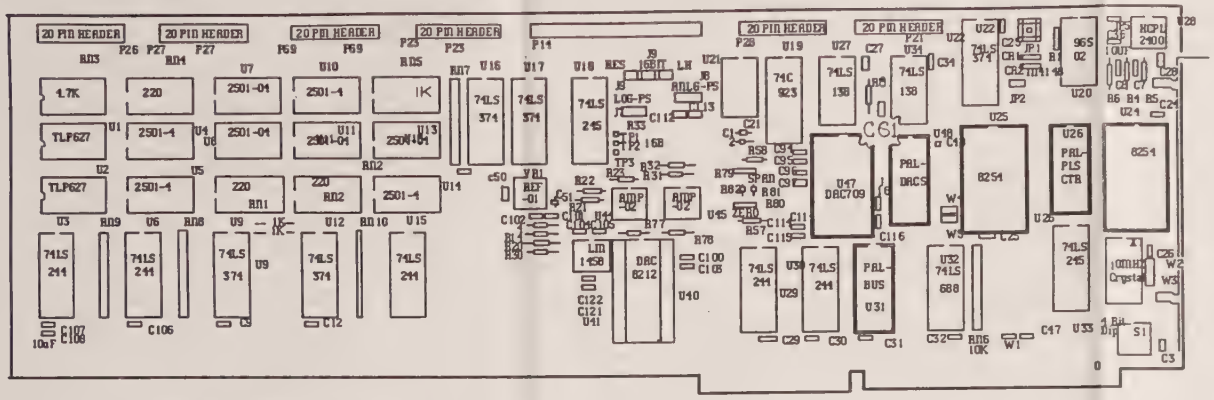


Figure 12-12F. Digital/Analog I/O, Schematic (6/6)



1- INSTALL BRACKET AS SHOWN
2- INSTALL SOCKETS FOR U24, U25, U26, U31, & U48
3- IF RN3 IS NOT AVAILABLE, USE 8 RESISTORS 4.7K.
4- DO NOT LOAD:
U42, U43, C101, 102, C110, C111
R58, R79
U49, U46

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
C	PER ECO 2251	5/[illegible]/91	TS
D	PER ECO 2447	7/[illegible]/91	TS

QTY	QTY	ITEM NO	PART NUMBER	DESCRIPTION	REMARKS

PARTS LIST

MATL

FINISH

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DECIMALS .X ±
.XX ±
.XXX ±

ANGLES ±

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CODE IDENT NO. 52654

UTi 2030 Fortune Drive San Jose CA 95131

TITLE ASSY, PCB DAIO QTRT

SIZE B | DWG NO 04330 | REV D

SCALE | SHEET 1 OF 2

NEXT ASSY | USED ON

NOTES - UNLESS OTHERWISE SPECIFIED

Figure 12-12G. Digital/Analog I/O, Assembly Drawing

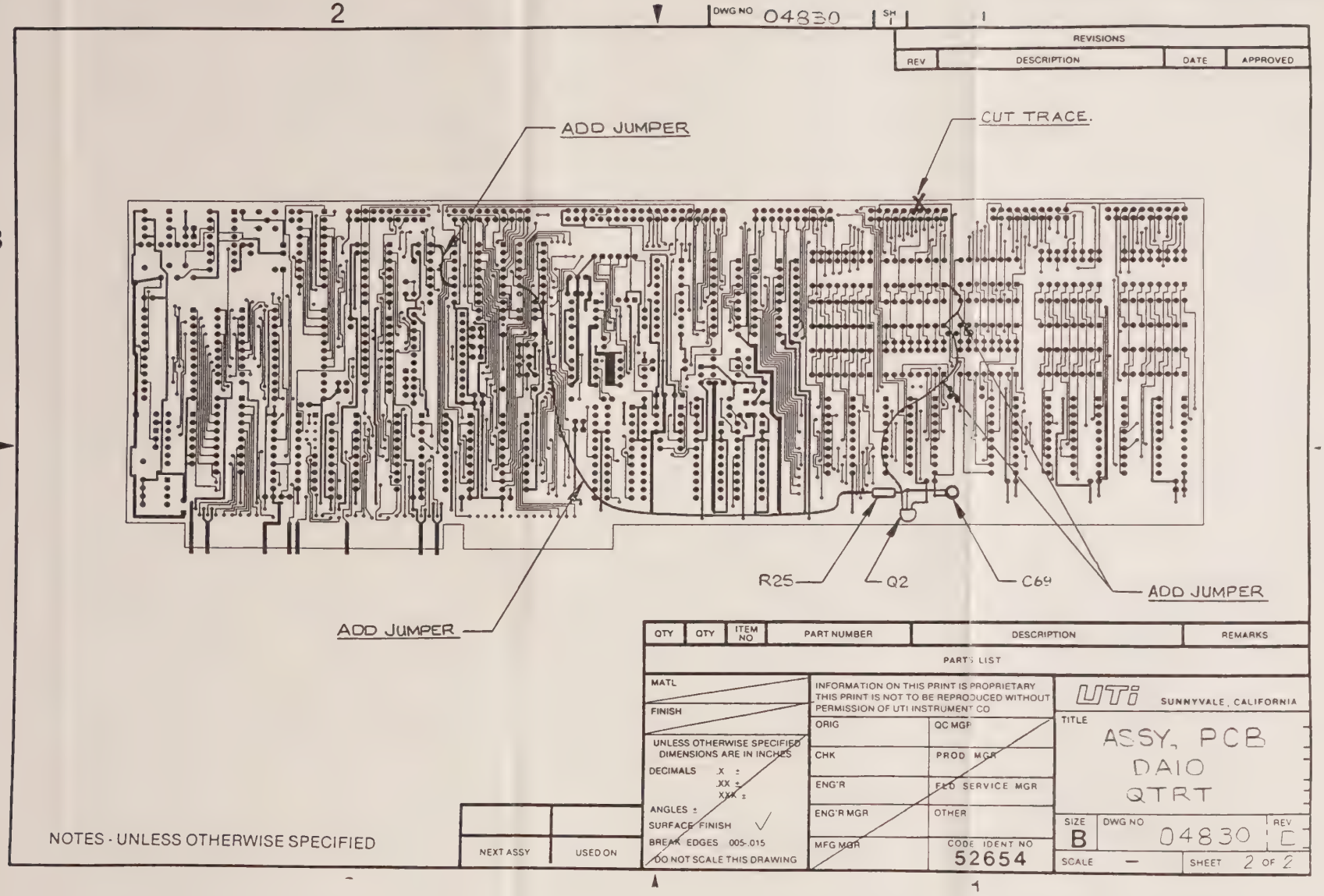


Figure 12-12H. Digital/Analog I/O, Assembly Drawing (2/2)

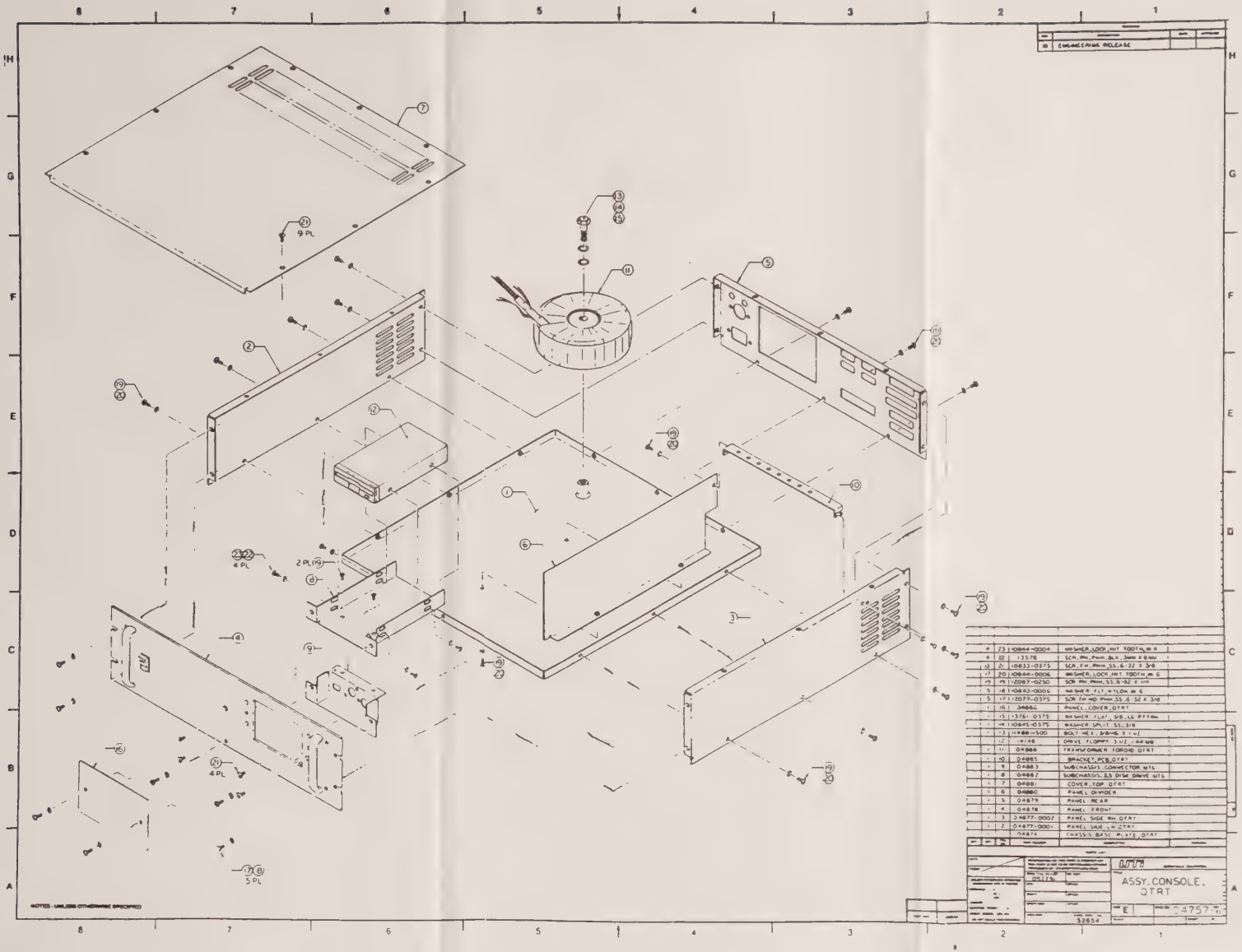


Figure 12-13. Console, QTRT (Station Controller), Assembly Drawing

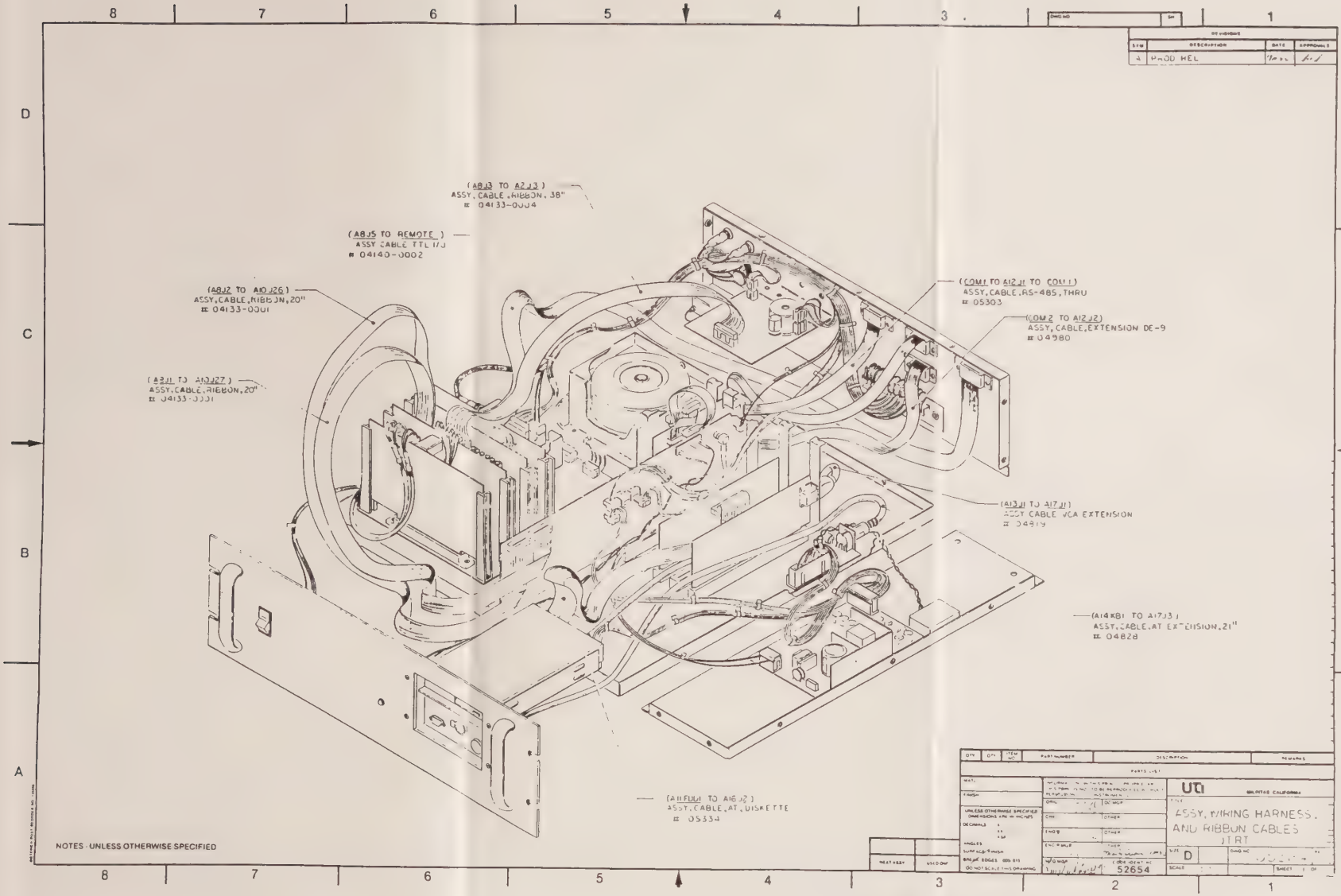
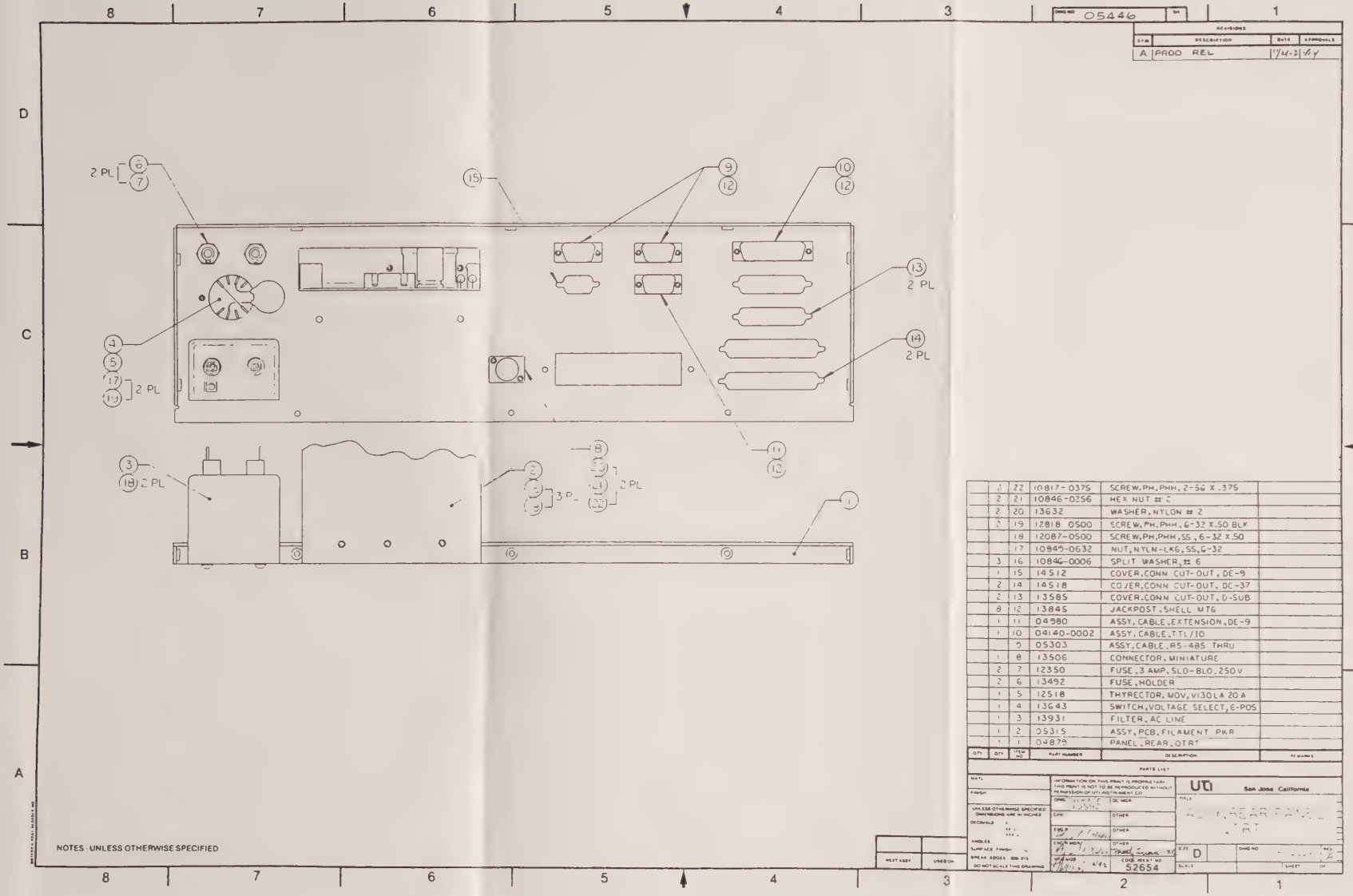


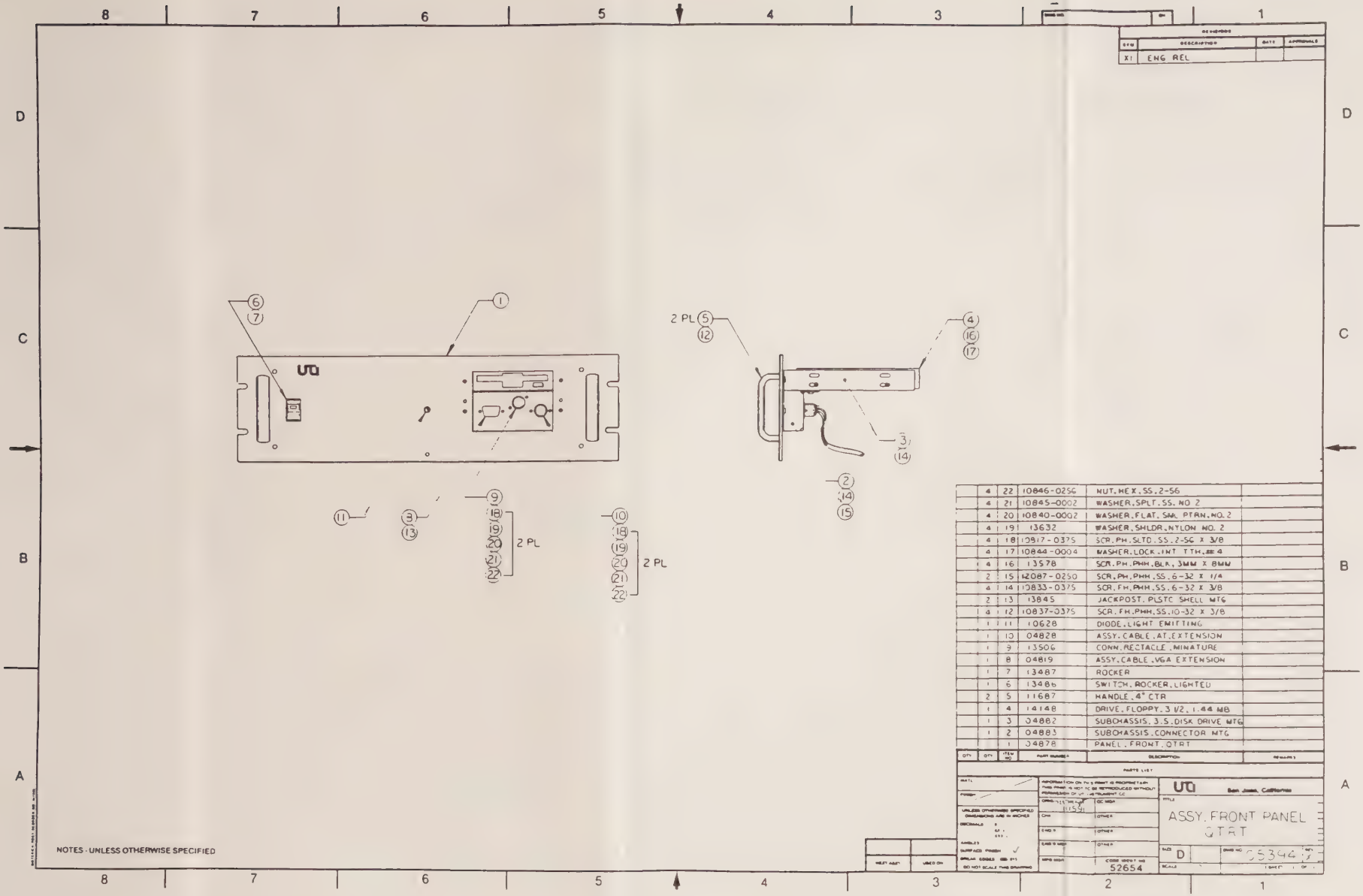
Figure 12-14. Wiring Harness and Ribbon Cables, Assembly Drawing



QTY	ITEM NO	PART NUMBER	DESCRIPTION
3	22	10817-0375	SCREW,PH,PHM,2-56 X .375
2	21	10846-0256	HEX NUT # 2
2	20	13632	WASHER,NYLON # 2
2	19	12818 0500	SCREW,PH,PHM,6-32 X.50 BLK
	18	12087-0500	SCREW,PH,PHM,SS,6-32 X.50
	17	10849-0632	NUT,NYLN-LKG,SS,6-32
3	16	10846-0006	SPLIT WASHER,# 6
1	15	14512	COVER,CONN CUT-OUT,DE-9
2	14	14518	COVER,CONN CUT-OUT,DC-37
2	13	13585	COVER,CONN CUT-OUT,D-SUB
8	12	13845	JACKPOST,SHELL MTG
1	11	04980	ASSY,CABLE,EXTENSION,DE-9
1	10	04140-0002	ASSY,CABLE,TTL/IO
	9	05303	ASSY,CABLE,RS-485 THRU
1	8	13506	CONNECTOR,MINIATURE
2	7	12350	FUSE,3 AMP,SLO-BLO,250V
2	6	13492	FUSE,HOLDER
1	5	12518	THYRECTOR,MOV,V130LA 20A
1	4	13643	SWITCH,VOLTAGE SELECT,6-POS
1	3	13931	FILTER,AC LINE
1	2	05315	ASSY,PCB,FILAMENT PWR
1	1	04879	PANEL,REAR,QTRT

PARTS LIST

Figure 12-15. Rear Panel, QTRT (Station Controller), Assembly Drawing



QTY	ITEM NO	PART NUMBER	DESCRIPTION
4	22	10846-0256	NUT, HEX, SS, 2-56
4	21	10845-0002	WASHER, SPLT, SS, NO 2
4	20	10840-0002	WASHER, FLAT, SML PTRN, NO. 2
4	19	13632	WASHER, SHLDR, NYLON NO. 2
4	18	10917-0375	SCR, PH, SLTD, SS, 2-56 X 3/8
4	17	10844-0004	WASHER, LOCK, INT TTH, #4
4	16	13578	SCR, PH, PHM, BLK, 3MM X 8MM
2	15	12087-0250	SCR, PH, PHM, SS, 6-32 X 1/4
4	14	10833-0375	SCR, FH, PHM, SS, 6-32 X 3/8
2	13	13845	JACKPOST, PLSTC SHELL MTG
4	12	10837-0375	SCR, FH, PHM, SS, 10-32 X 3/8
1	11	10628	DIODE, LIGHT EMITTING
1	10	04828	ASSY, CABLE, AT, EXTENSION
1	9	13506	CONN, RECTACLE, MINATURE
1	8	04819	ASSY, CABLE, VGA EXTENSION
1	7	13487	ROCKER
1	6	13486	SWITCH, ROCKER, LIGHTED
2	5	11687	HANDLE, 4" CTR
1	4	14148	DRIVE, FLOPPY, 3 1/2, 1.44 MB
1	3	04882	SUBCHASSIS, 3.5, DISK DRIVE MTG
1	2	04883	SUBCHASSIS, CONNECTOR MTG
1	1	04878	PANEL, FRONT, QTRT

Figure 12-16. Front Panel, QTRT (Station Controller), Assembly Drawing

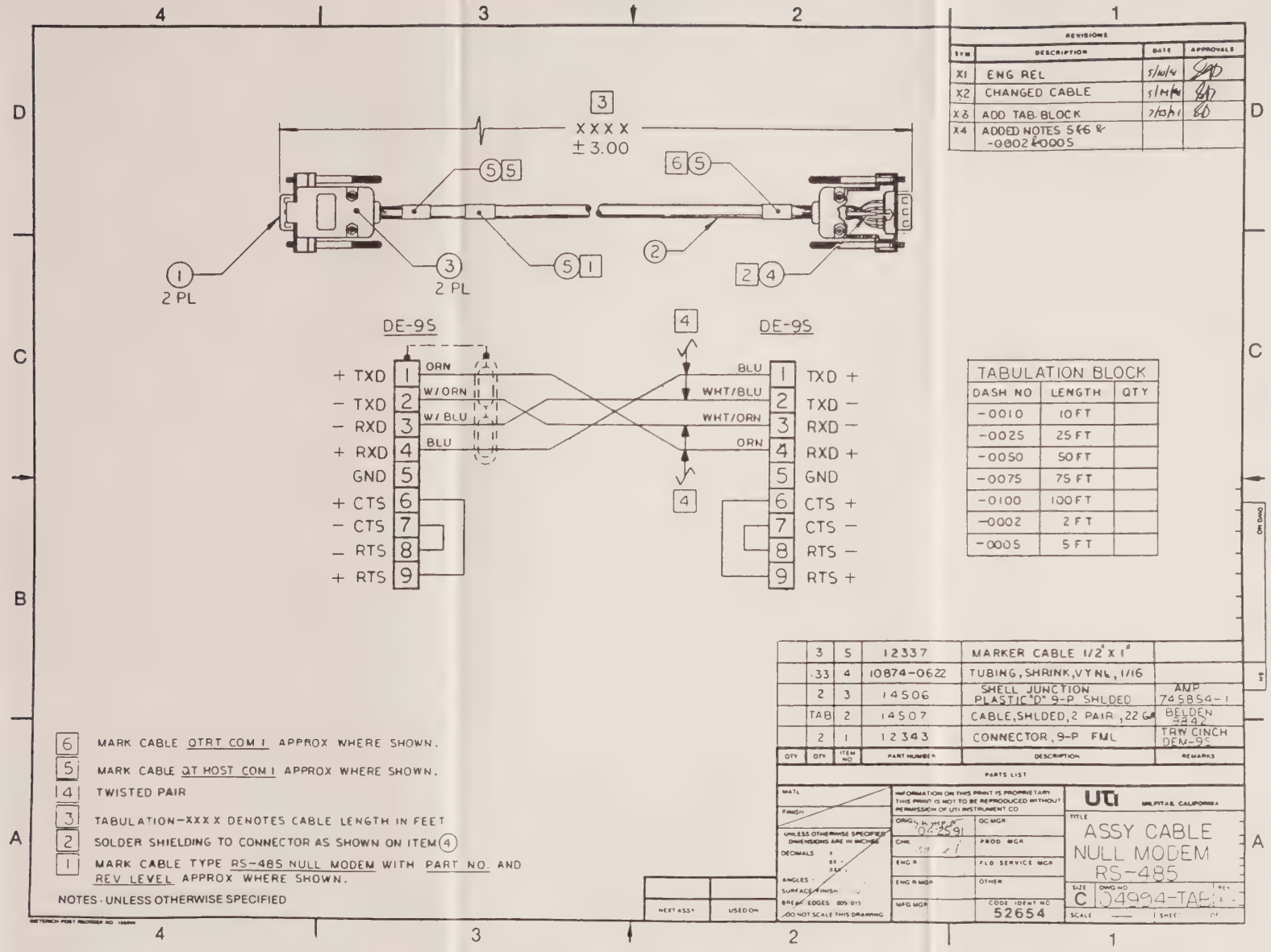


Figure 12-17. Null Modem Cable, RS-485, Assembly Drawing

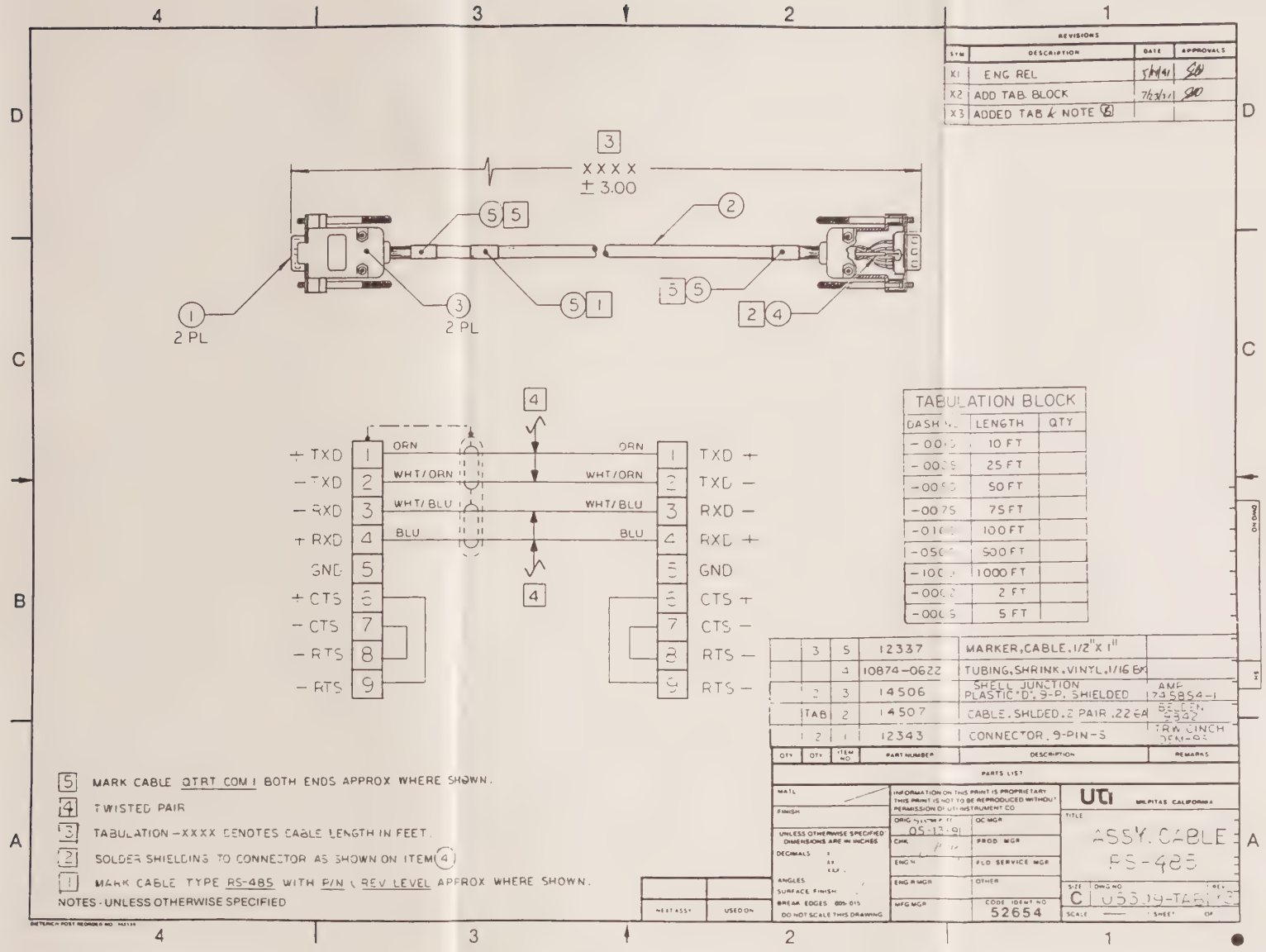


Figure 12-18. Cable, RS-485, Assembly Drawing

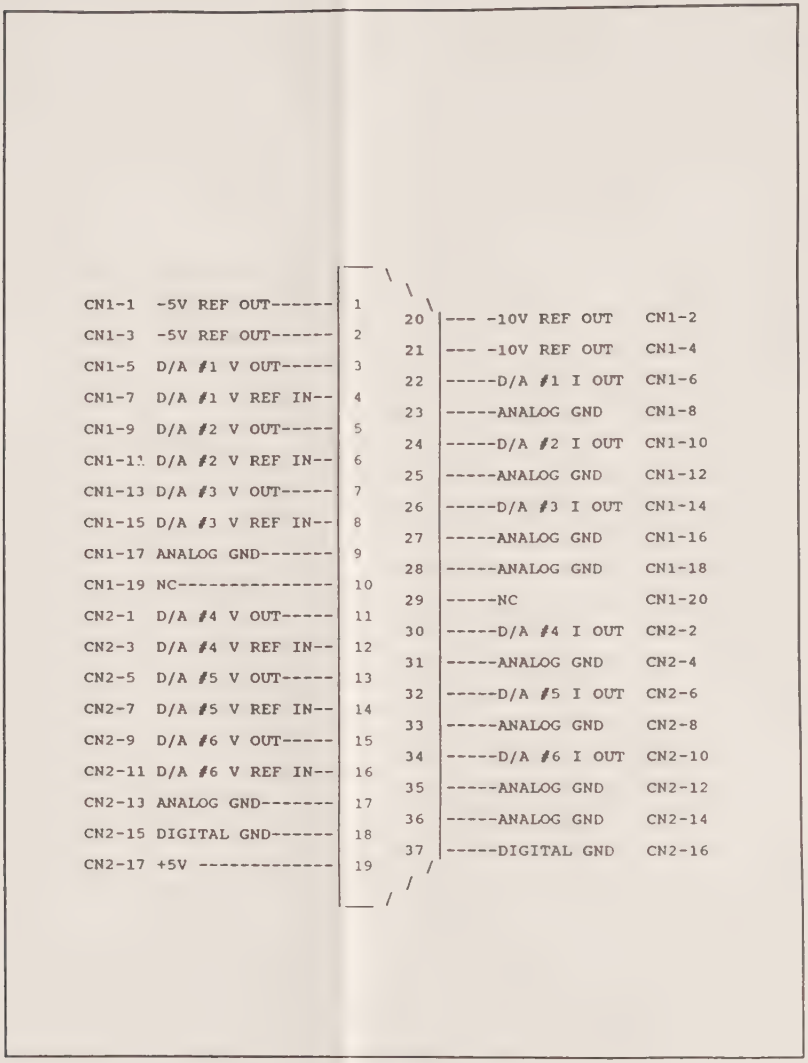

CN1-1 -5V REF OUT------ 1
CN1-3 -5V REF OUT------ 2
CN1-5 D/A #1 V OUT----- 3
CN1-7 D/A #1 V REF IN-- 4
CN1-9 D/A #2 V OUT----- 5
CN1-11 D/A #2 V REF IN-- 6
CN1-13 D/A #3 V OUT----- 7
CN1-15 D/A #3 V REF IN-- 8
CN1-17 ANALOG GND------- 9
CN1-19 NC---------- 10
CN2-1 D/A #4 V OUT----- 11
CN2-3 D/A #4 V REF IN-- 12
CN2-5 D/A #5 V OUT----- 13
CN2-7 D/A #5 V REF IN-- 14
CN2-9 D/A #6 V OUT----- 15
CN2-11 D/A #6 V REF IN-- 16
CN2-13 ANALOG GND------- 17
CN2-15 DIGITAL GND------ 18
CN2-17 +5V ---------- 19
20 --- -10V REF OUT CN1-2
21 --- -10V REF OUT CN1-4
22 -----D/A #1 I OUT CN1-6
23 -----ANALOG GND CN1-8
24 -----D/A #2 I OUT CN1-10
25 -----ANALOG GND CN1-12
26 -----D/A #3 I OUT CN1-14
27 -----ANALOG GND CN1-16
28 -----ANALOG GND CN1-18
29 -----NC CN1-20
30 -----D/A #4 I OUT CN2-2
31 -----ANALOG GND CN2-4
32 -----D/A #5 I OUT CN2-6
33 -----ANALOG GND CN2-8
34 -----D/A #6 I OUT CN2-10
35 -----ANALOG GND CN2-12
36 -----ANALOG GND CN2-14
37 -----DIGITAL GND CN2-16

Figure 12-19. Analog I/O DB 37 Pin Connections for 6-Channel Analog Option

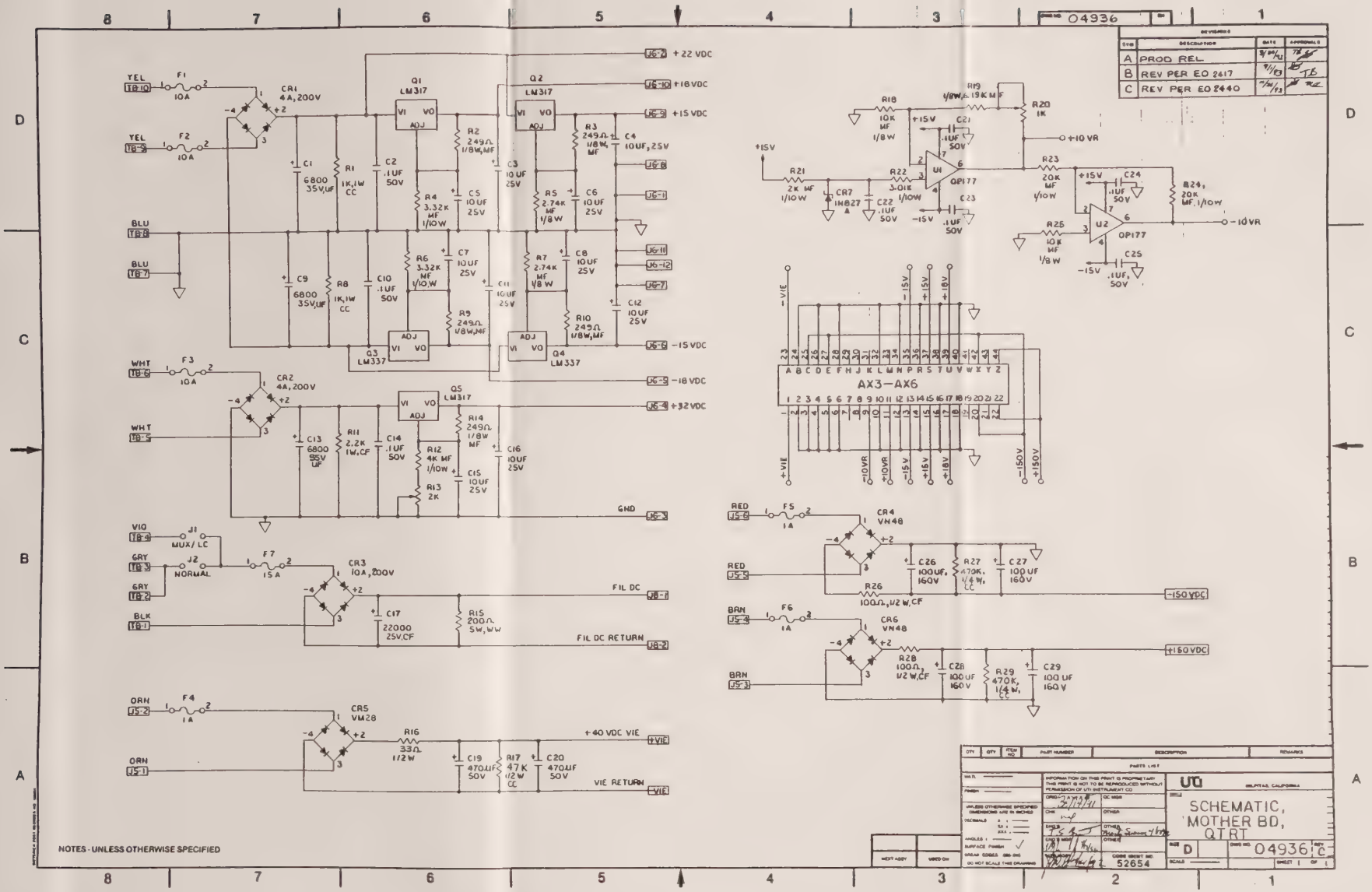


Figure 12-20. Mother Board, Schematic

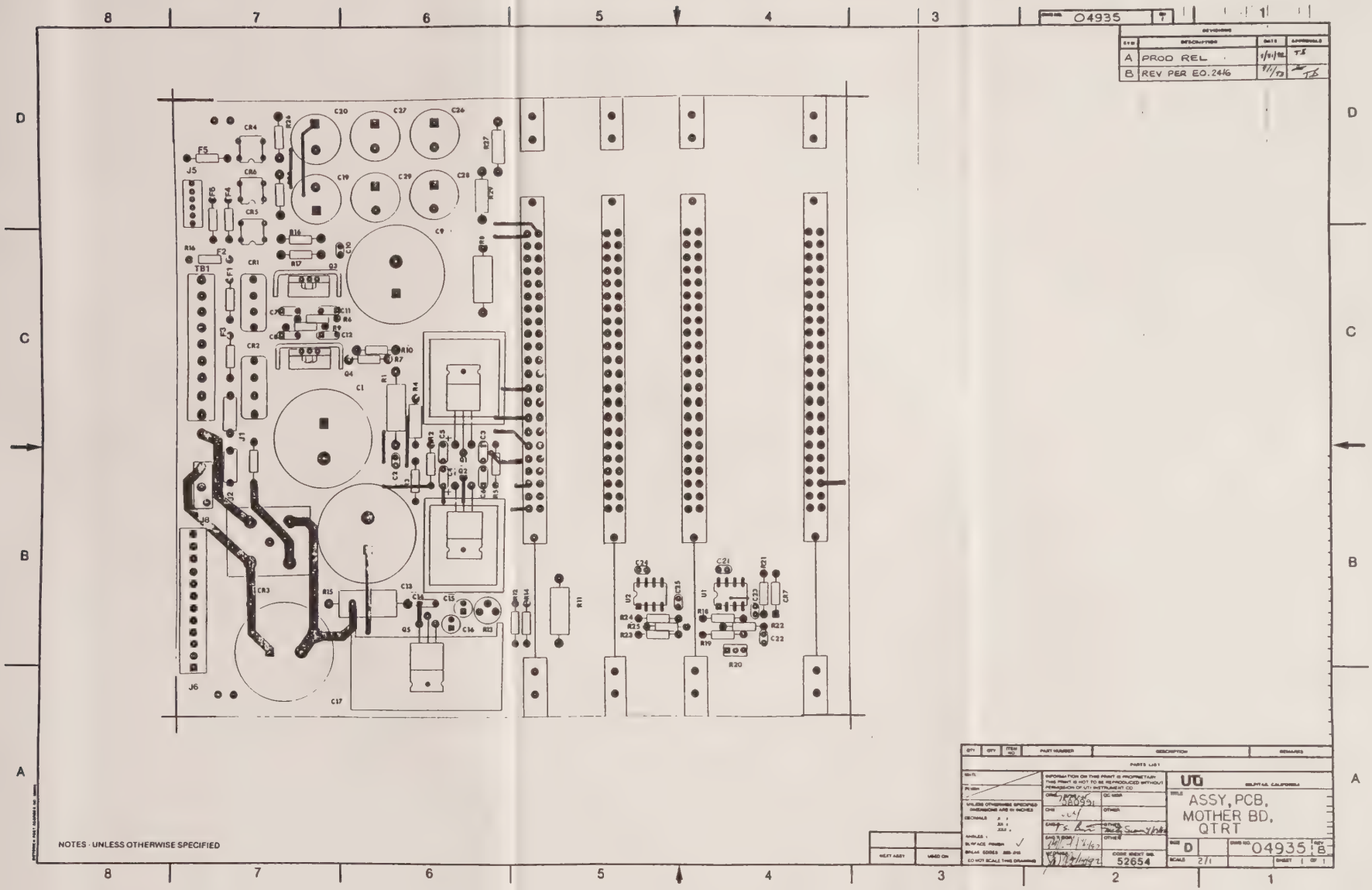


Figure 12-21. Mother Board, Assembly Drawing

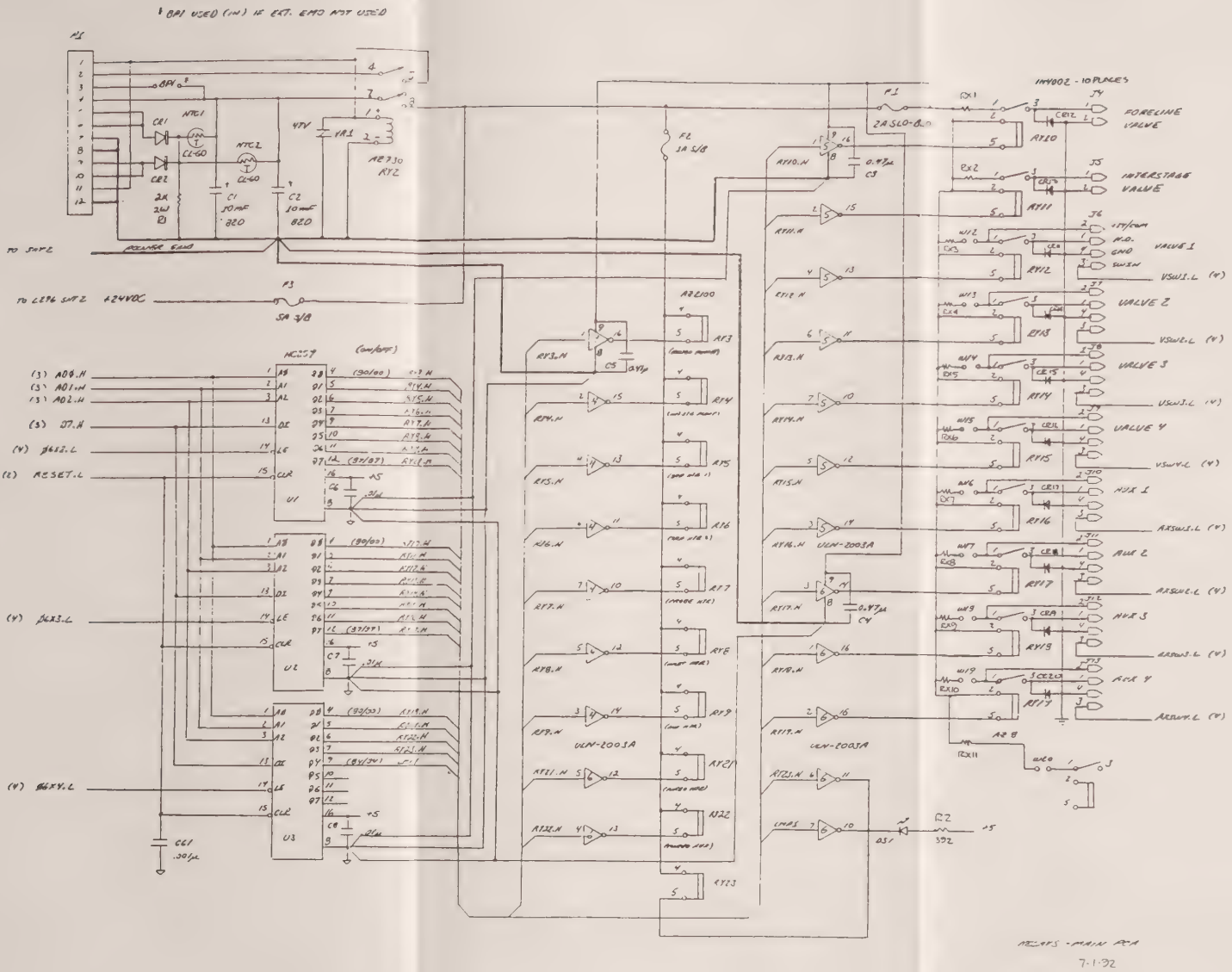
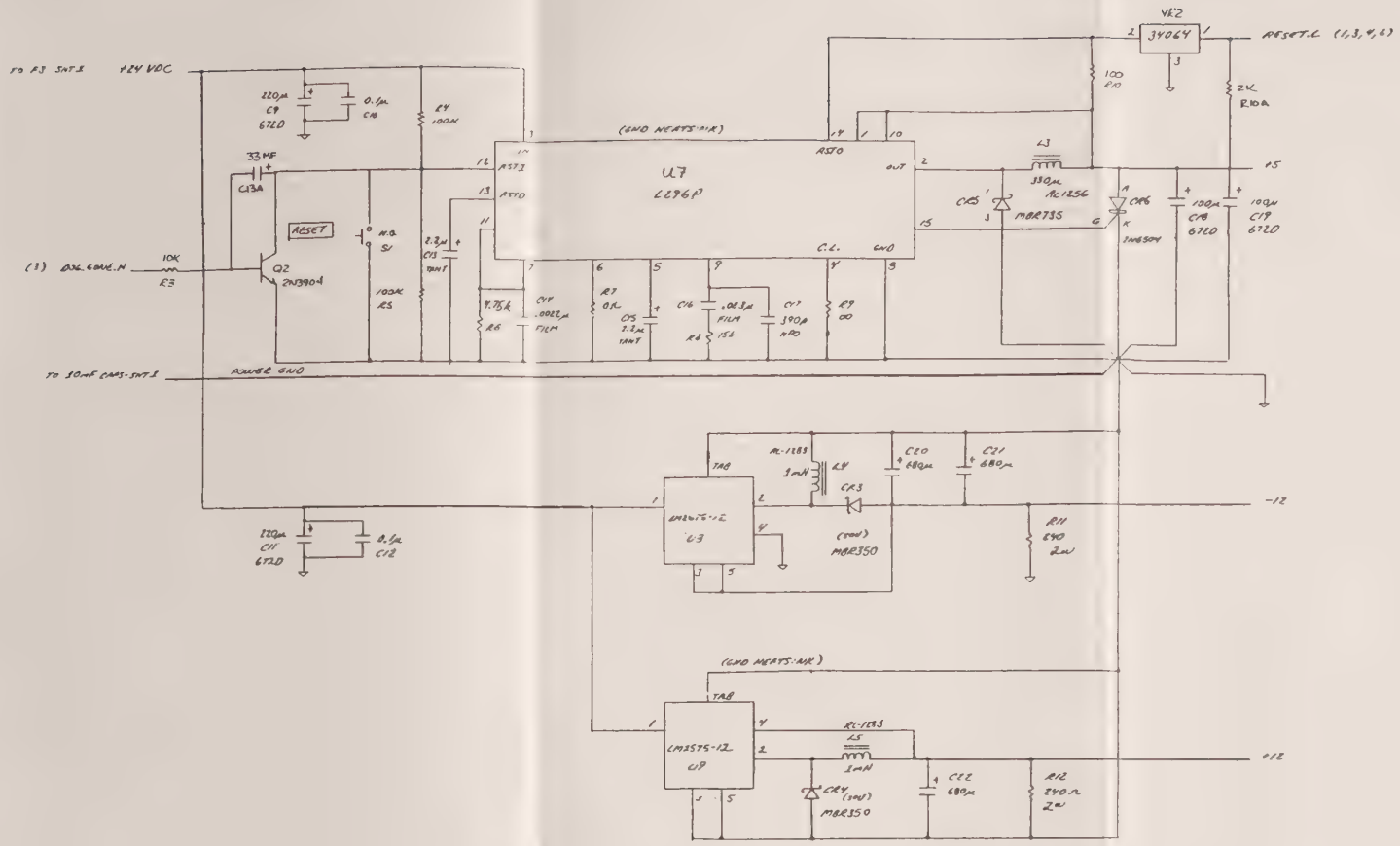


Figure 12-22A. Vacuum System Controller, Relays, Main DCA 1



POWER SUPPLY - MAIN PCA 2
7-1-92

Figure 12-22B. Vacuum System Controller, Power Supply, Main DCA 2

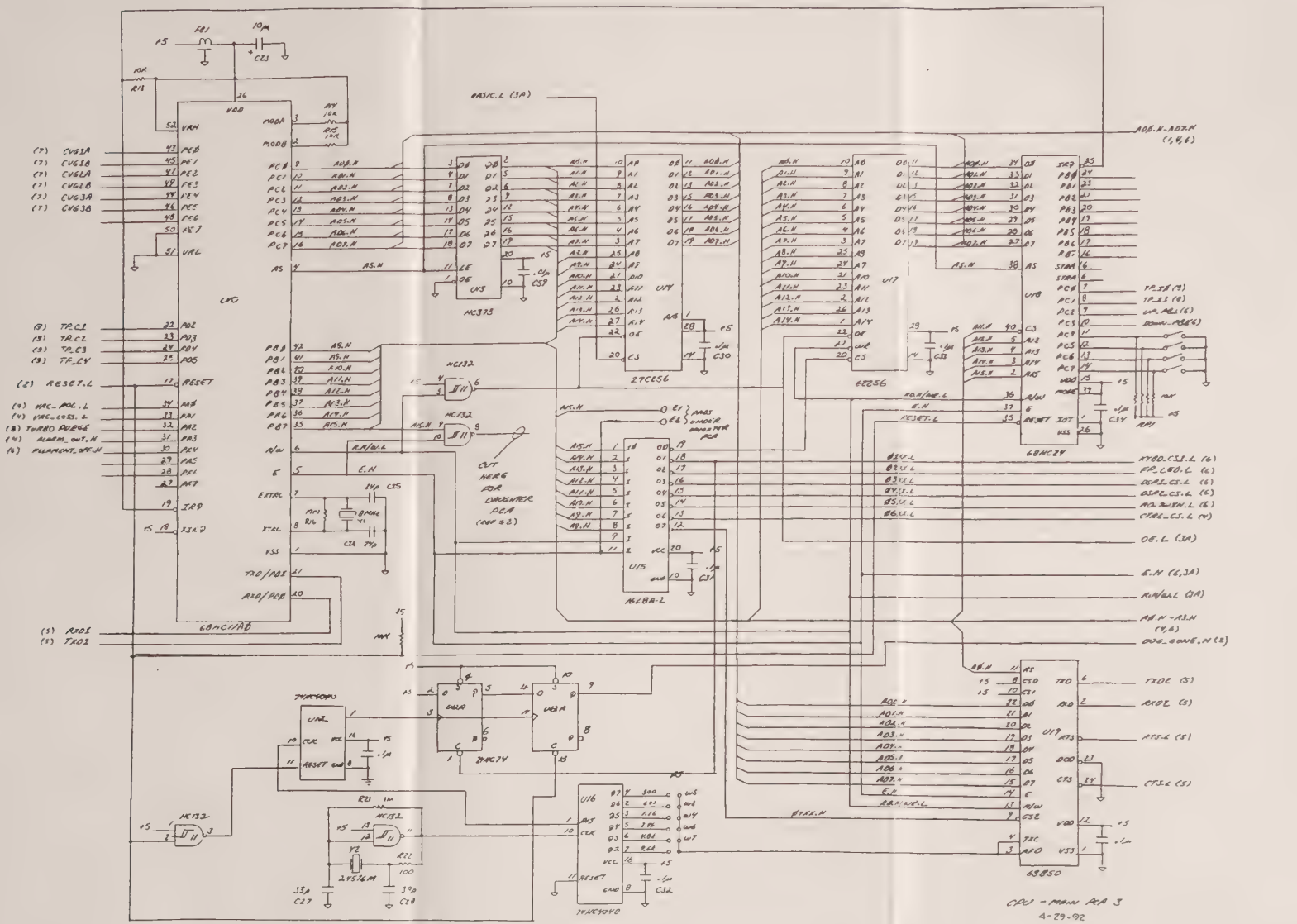
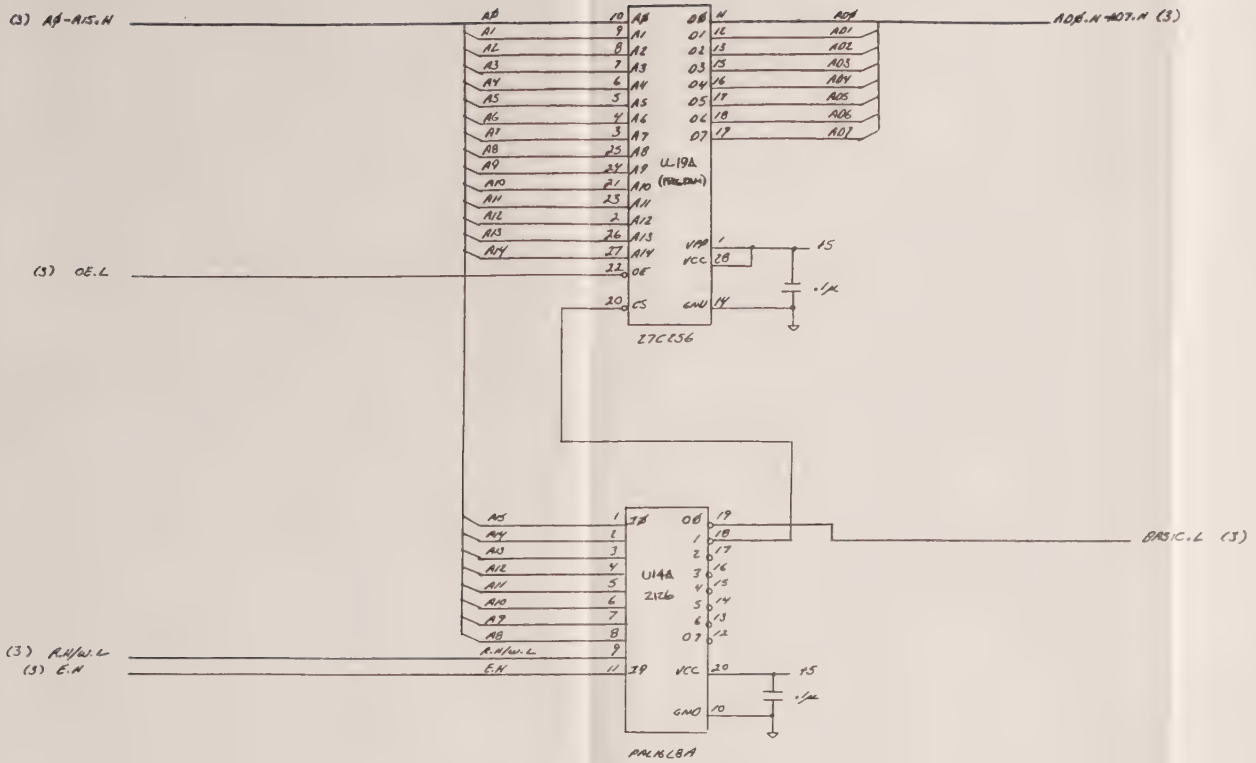


Figure 12-22C. Vacuum System Controller, CPU, Main DCA 3



CPU - MAIN PCA 3A
4-4-92

Figure 12-22D. Vacuum System Controller, CPU, Main DCA 3A

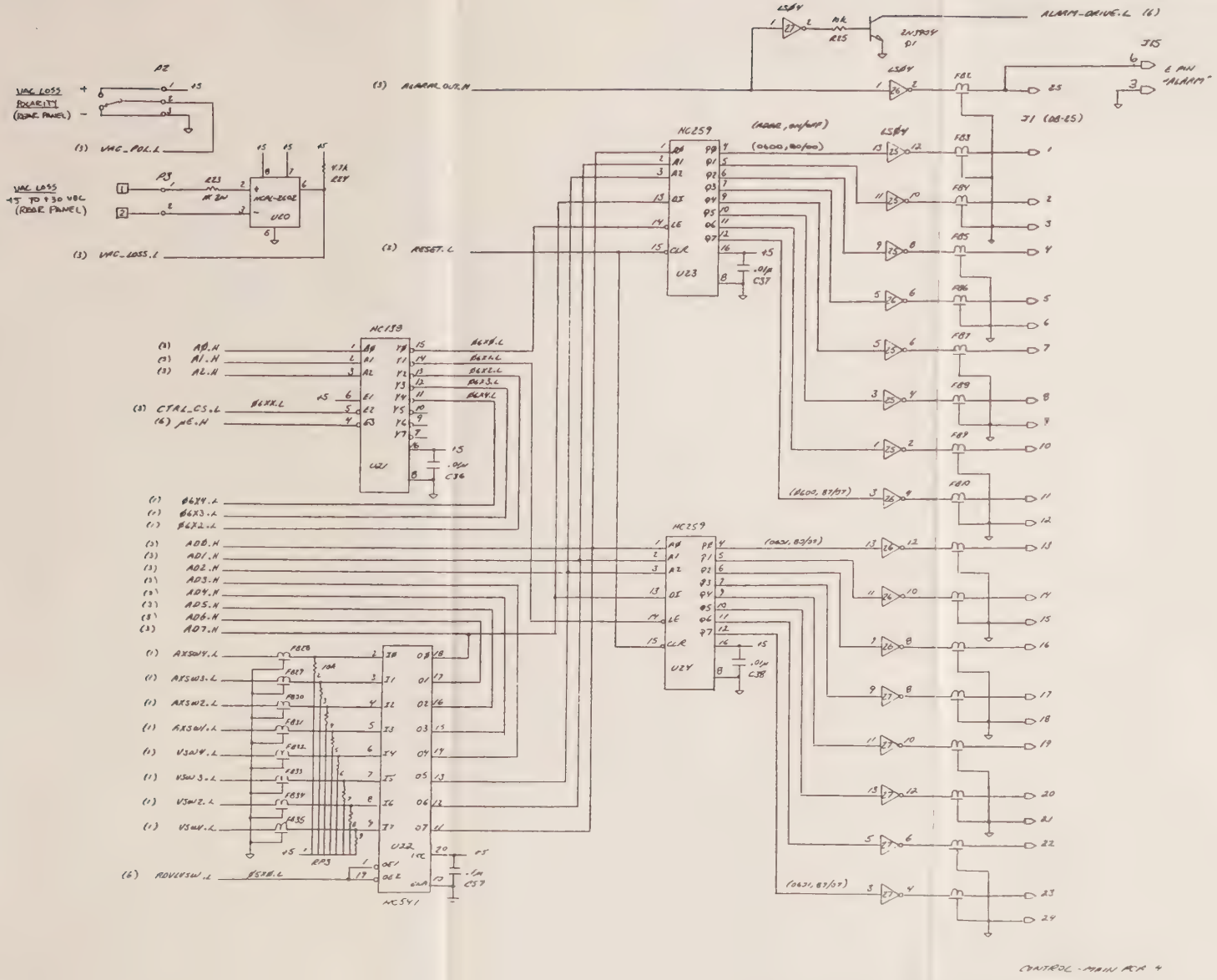
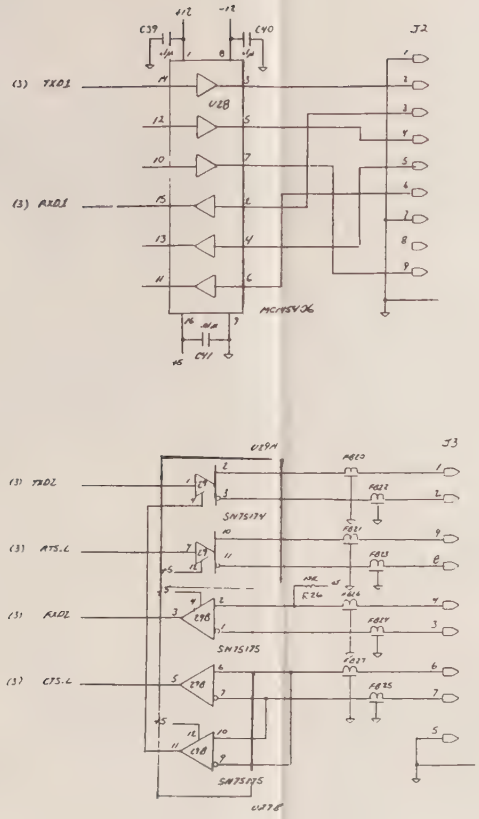
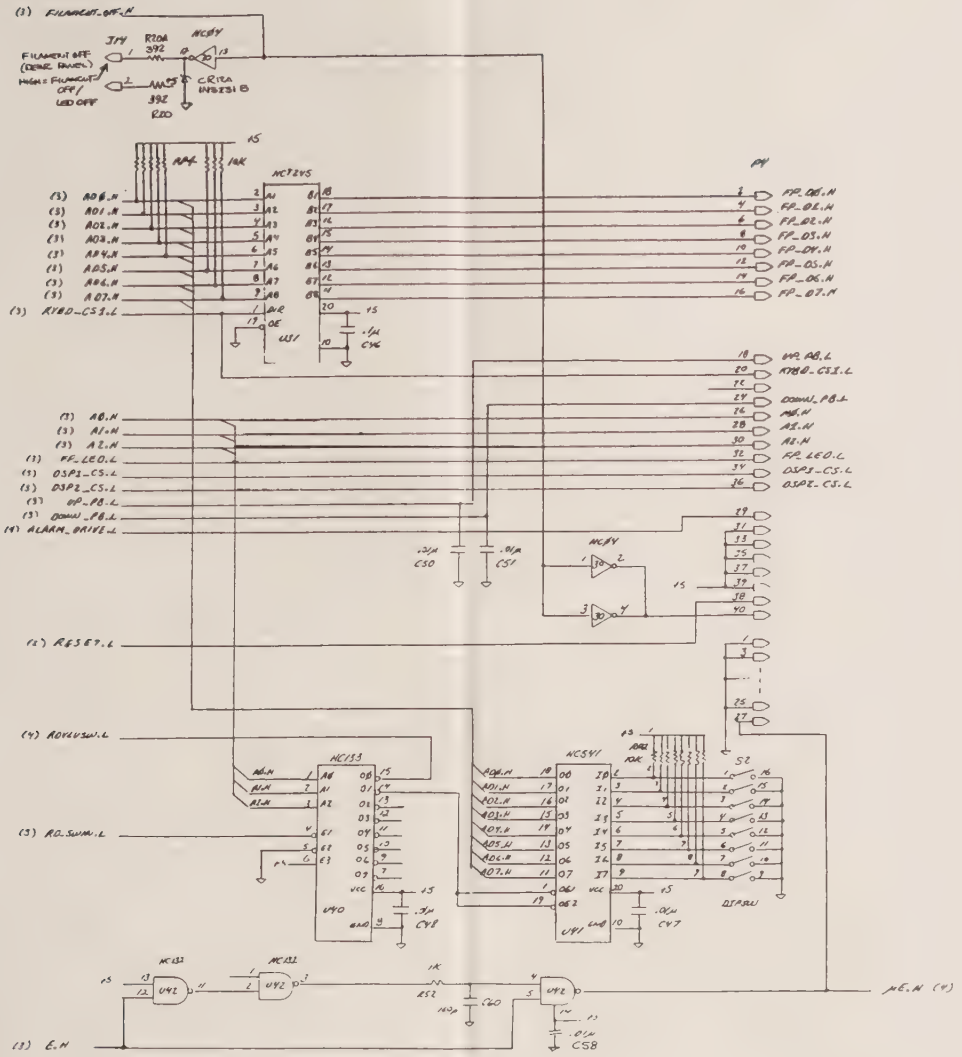


Figure 12-22E. Vacuum System Controller, Control, Main DCA 4



SERIAL I/O - MAIN PCA 3
10 15 91

Figure 12-22F. Vacuum System Controller, Signal I/O, Main DCA 5



FP CONN - MAIN PCB 6

4 OF 42

Figure 12-22G. Vacuum System Controller, FP Conn, Main DCA 6

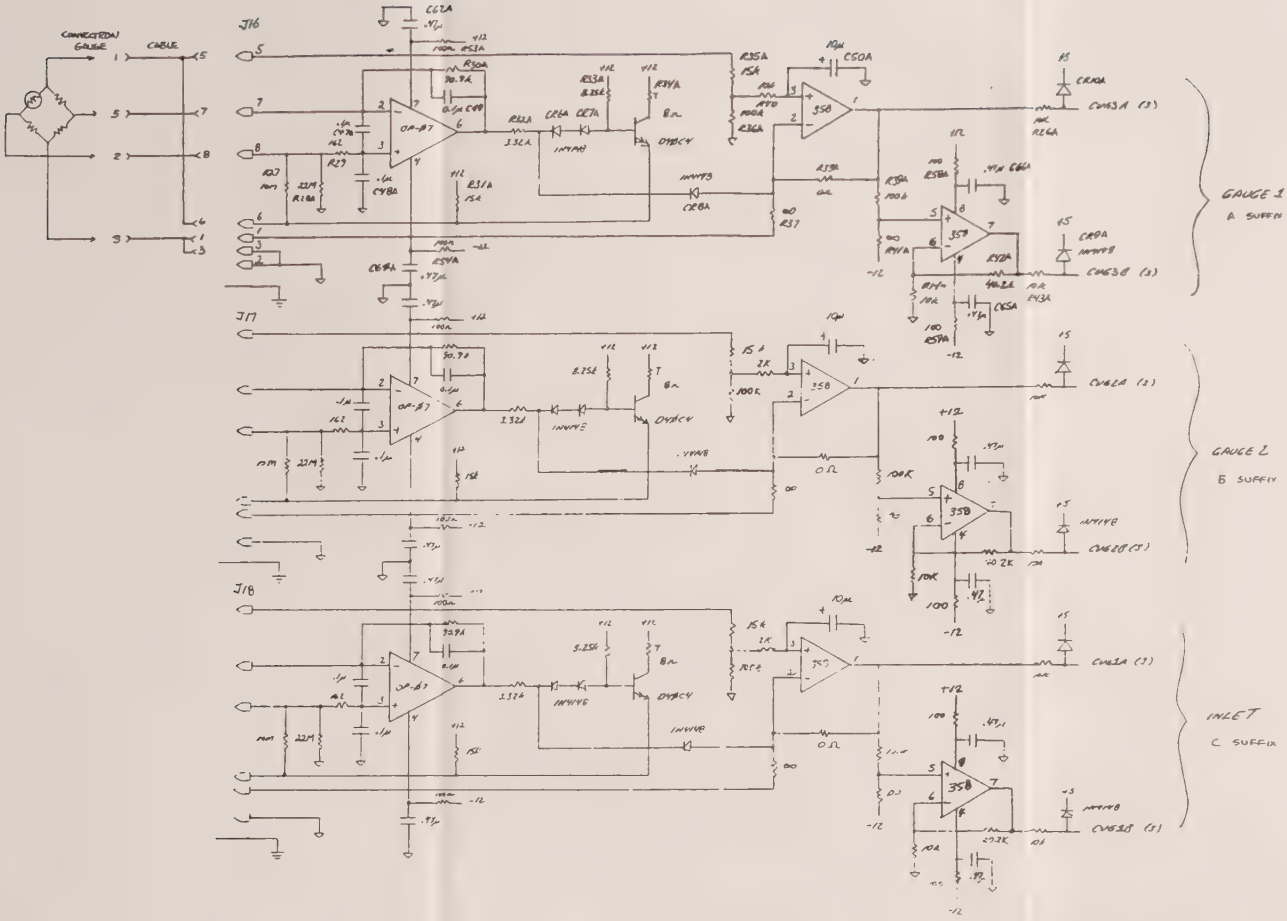
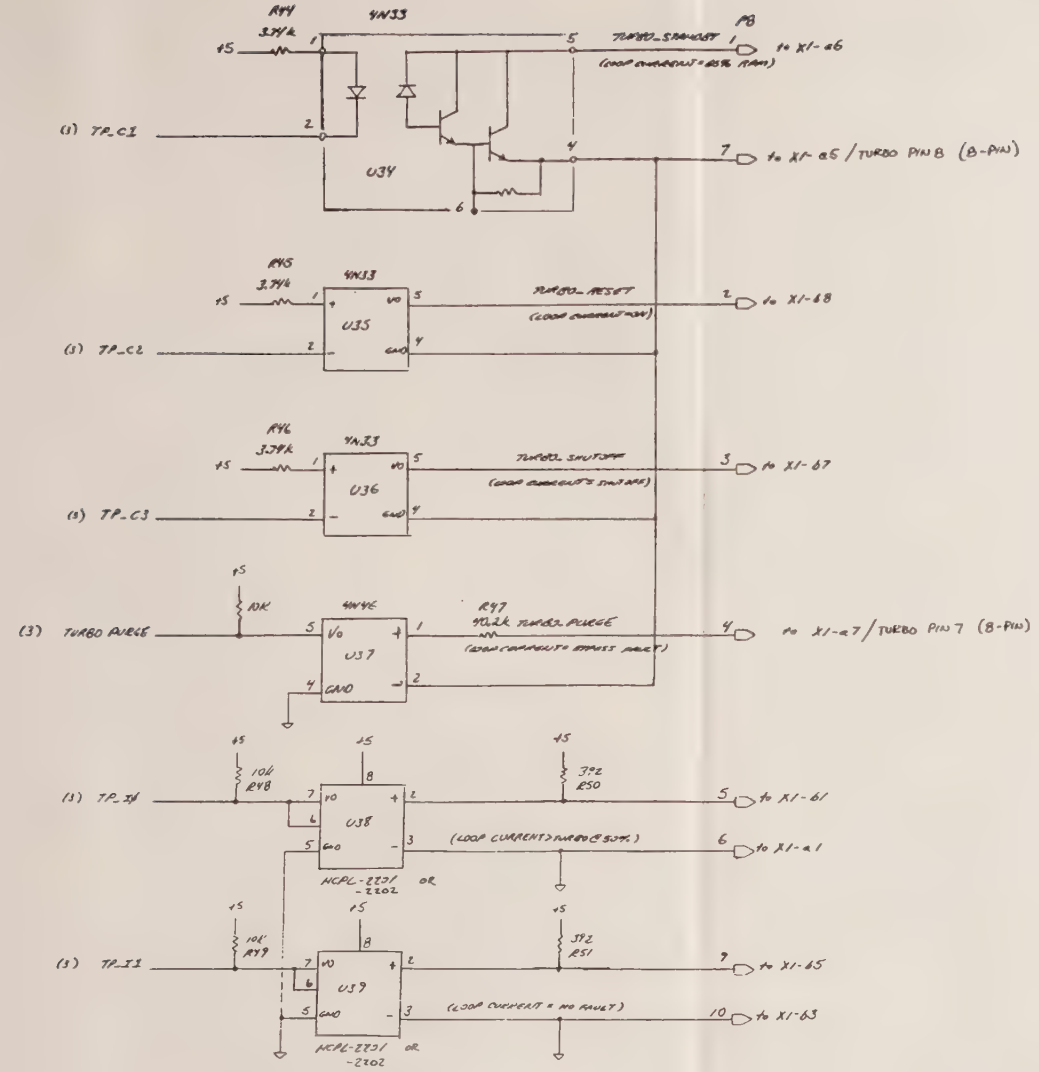


Figure 12-22H. Vacuum System Controller, Connections, Main DCA 7



TURBO - CIRCULAR 8-PIN

BLACK = 110VAC	1	TURBO FAN
WHITE = 110VAC	2	
GREEN	3	
	4	
RELAY 2	5	TURBO HEATER
PAGE "MAIN"	6	
PB/4 ; X1-A7	7	PURGE VALVE
PB/7 ; X1-A5	8	

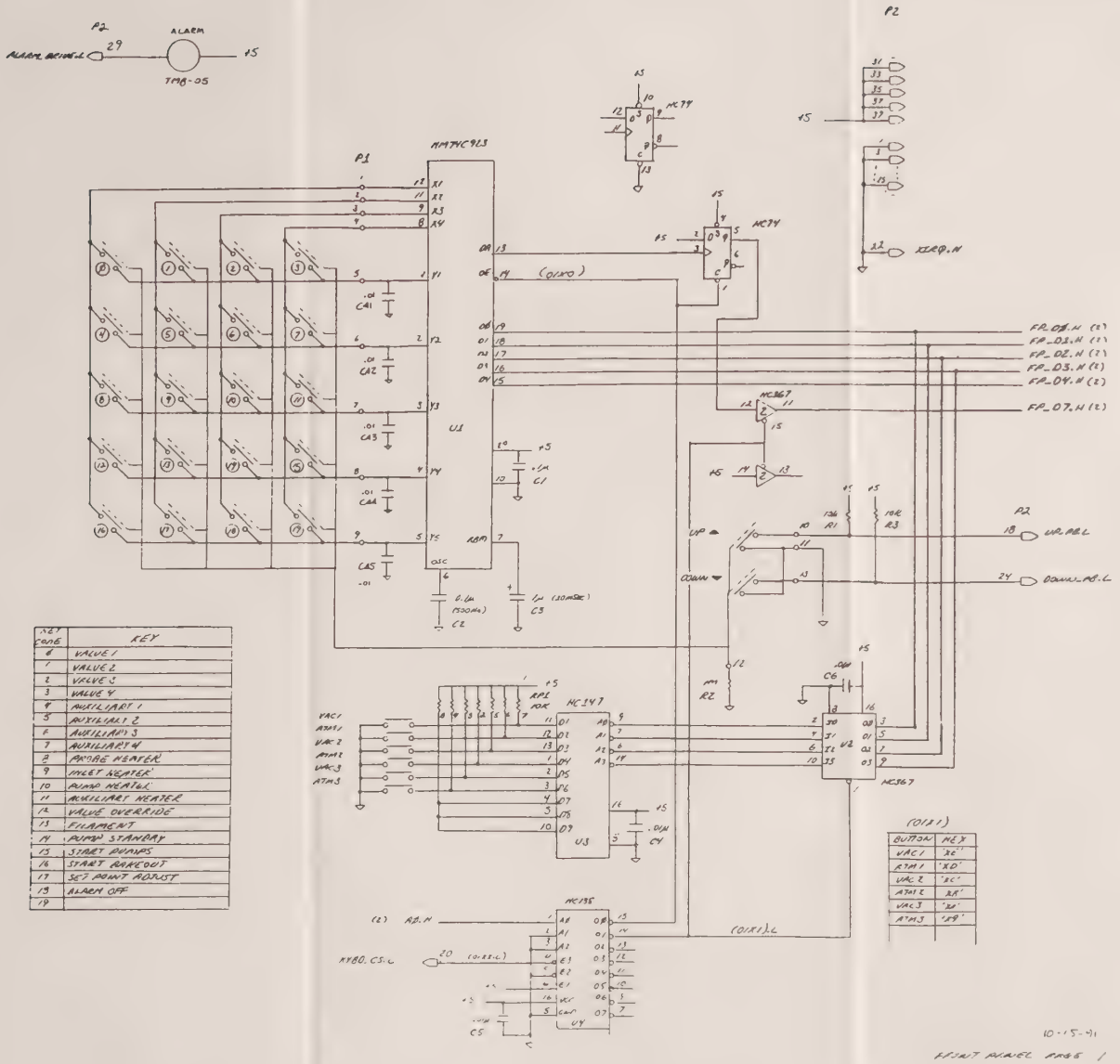
MAIN TURBO CONNECTOR

GREEN	X1-a8
110V - WHITE	X1-a2
110V - BLACK	X1-b2

TURBO OPTO - MAIN PCA B

10-15-91

Figure 12-22I. Vacuum System Controller, Turbo Opto, Main DCA 8



KEY CODE	KEY
0	VALVE 1
1	VALVE 2
2	VELVE 3
3	VALVE 4
4	AUXILIARY 1
5	AUXILIARY 2
6	AUXILIARY 3
7	AUXILIARY 4
8	PROBE HEATER
9	INLET HEATER
10	PUMP HEATER
11	AUXILIARY HEATER
12	VALVE OVERRIDE
13	FILAMENT
14	PUMP STANDBY
15	START PUMPS
16	START BAKEOUT
17	SET POINT ADJUST
18	ALARM OFF
19	

(0:1X1)

BUTTON	KEY
VAC1	'2C'
ATM1	'XD'
VAC2	'2C'
ATM2	'XA'
VAC3	'2A'
ATM3	'XB'

Figure 12-22J. Vacuum System Controller, Front Panel DCA (1/2)

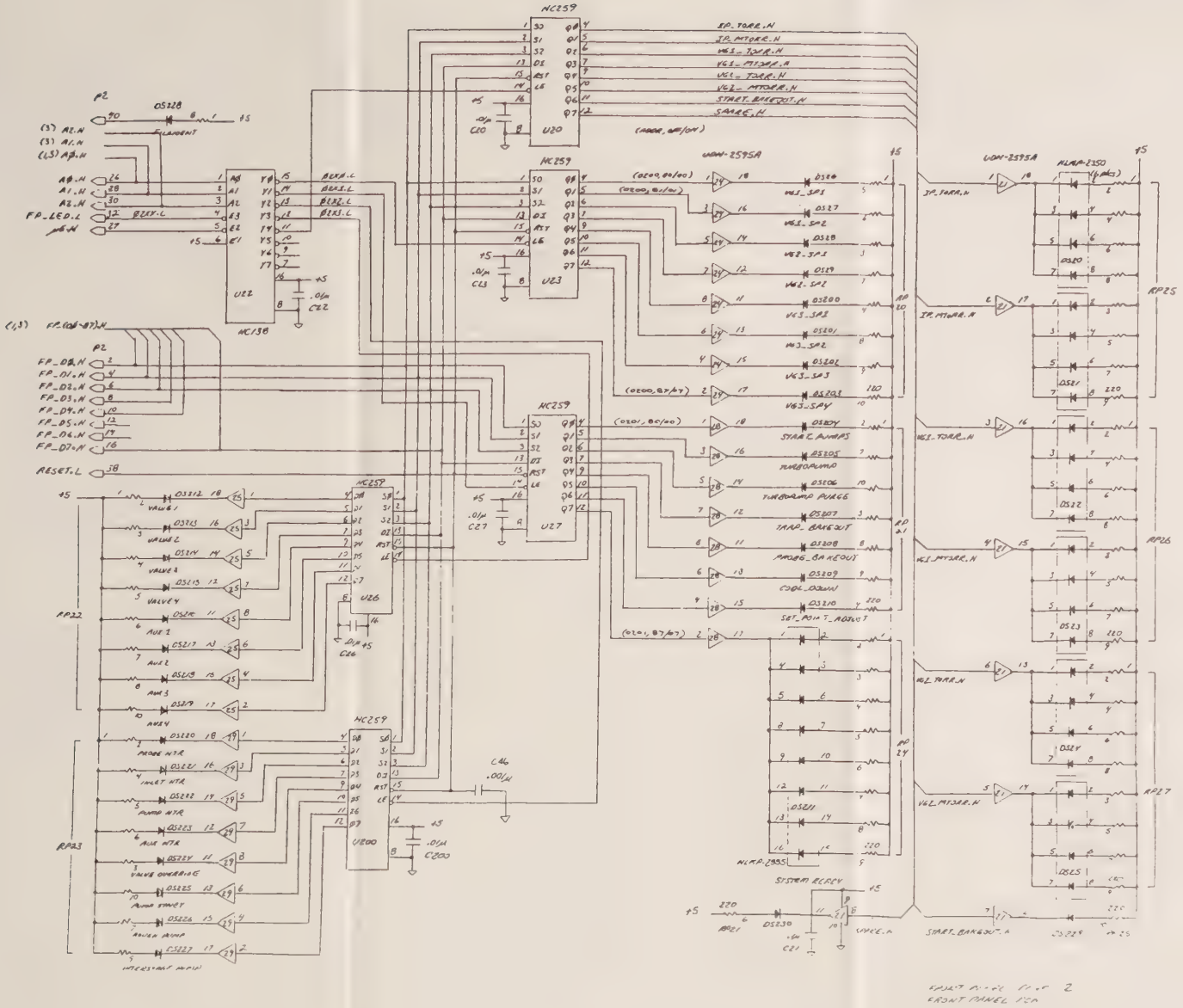


Figure 12-22K. Vacuum System Controller, Front Panel DCA (2/2)

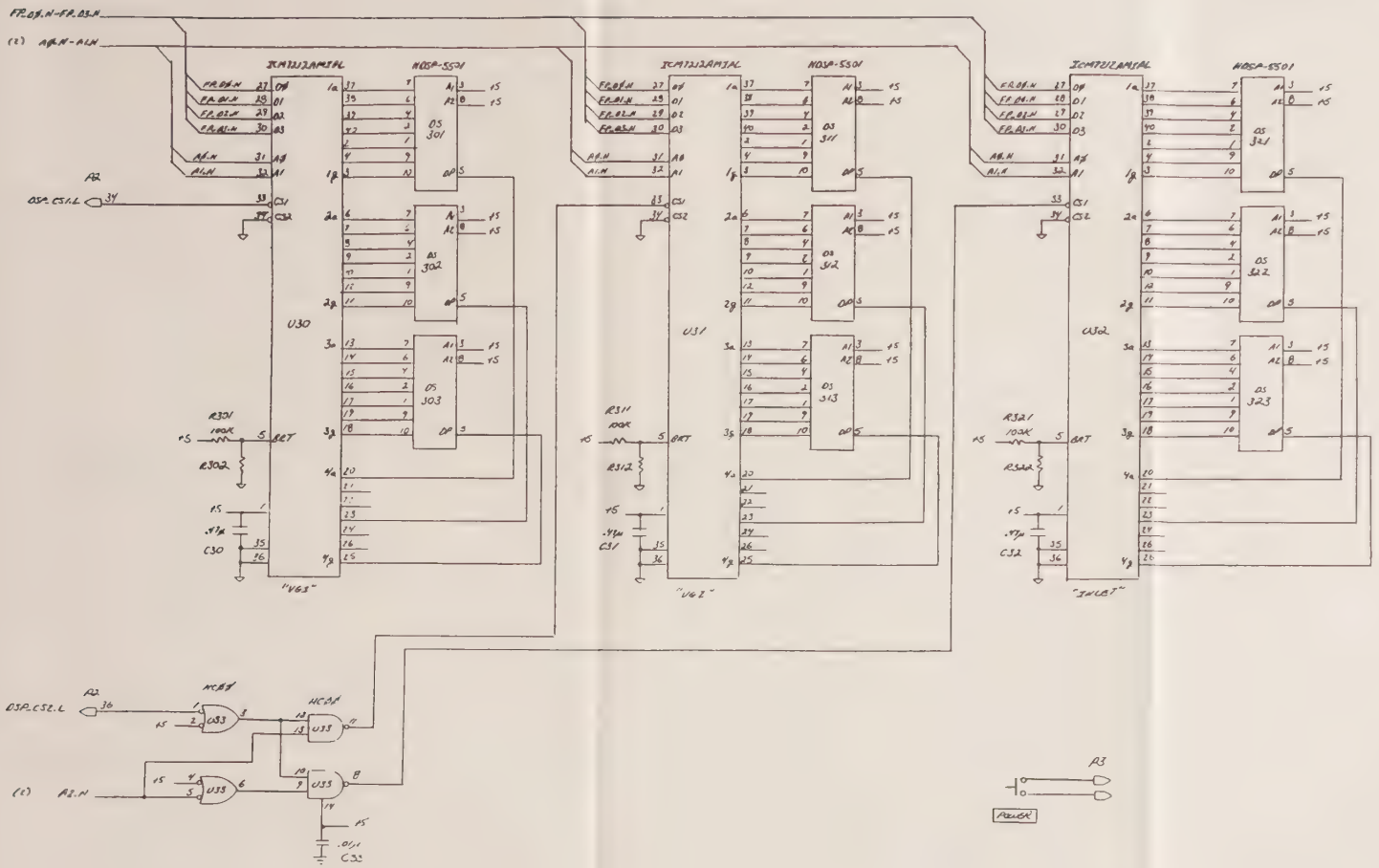


Figure 12-22L. Vacuum System Controller, 7-Segment Display, Front Panel 3

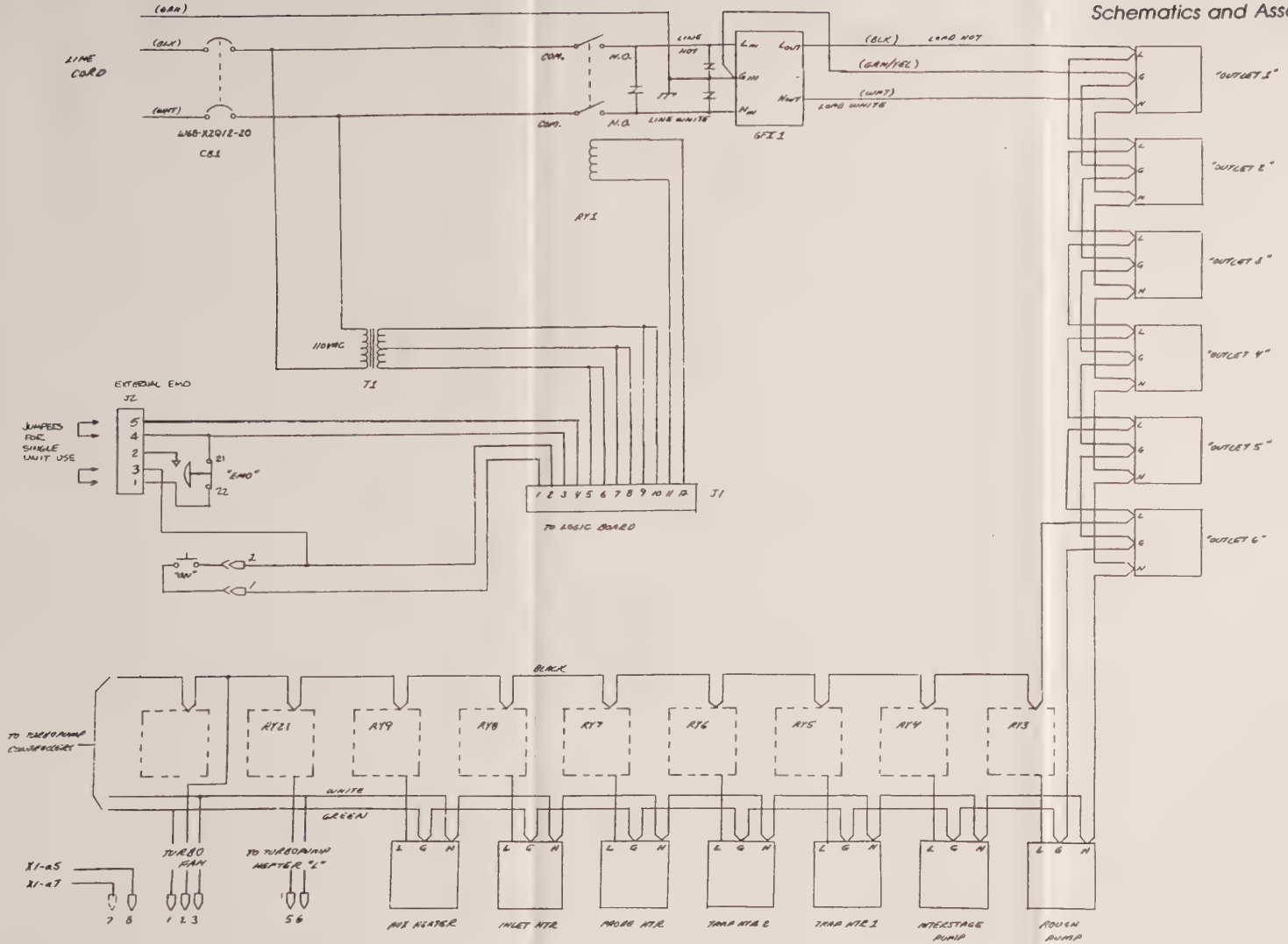


Figure 12-22M. Vacuum System Controller, Main Wire Harness

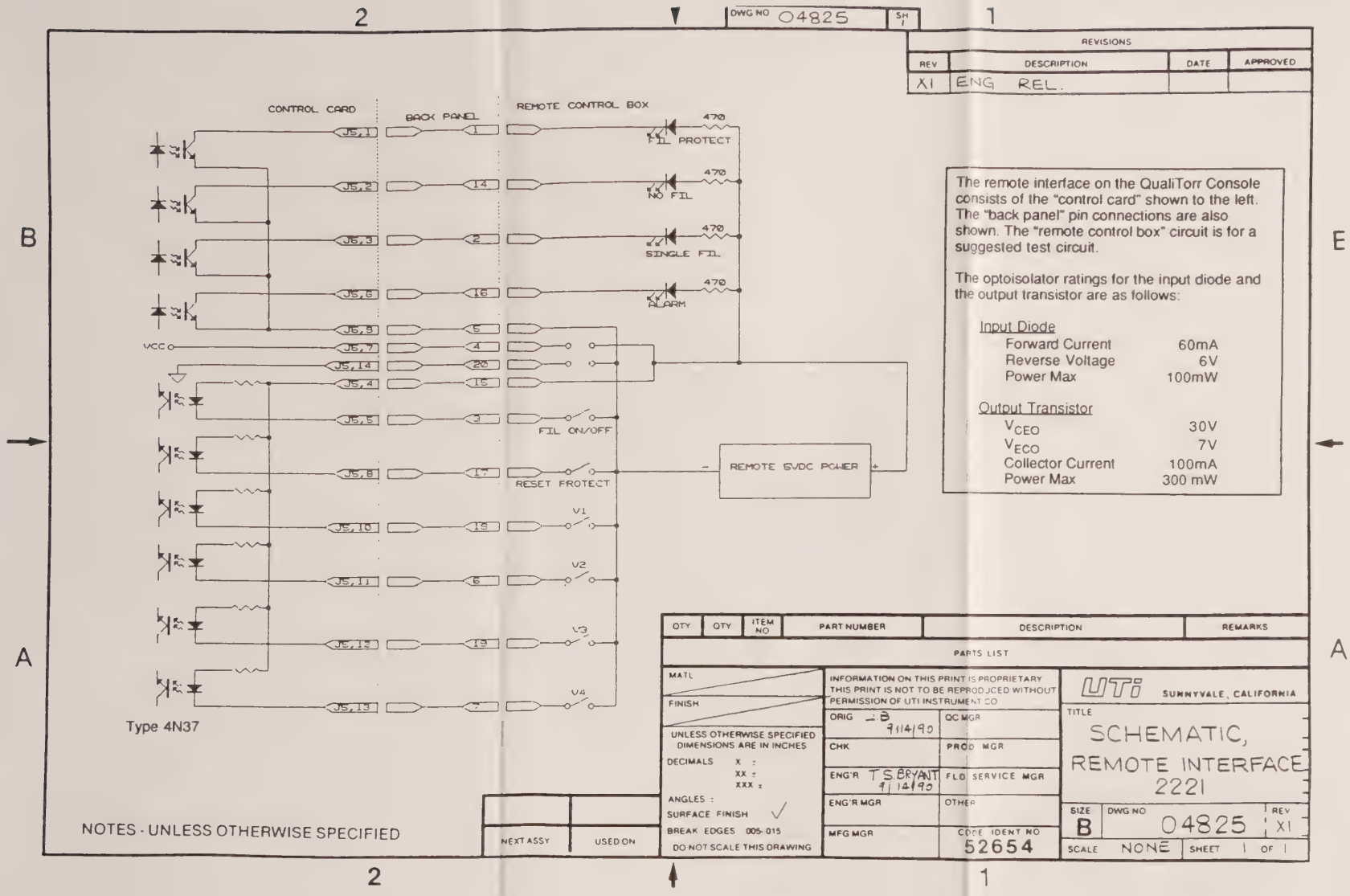


Figure 12-23. Remote Interface, Schematic

Appendix A

Vacuum System Considerations

This appendix provides a brief introduction to the use of high vacuum systems, pressure unit conventions and conversions, vacuum system contamination, and some rules and procedures to ensure a clean vacuum system.

A.1 Introduction

Everyone on earth lives in an environment of air that consists primarily of the elements oxygen and nitrogen. The air exerts a uniform pressure on all of the objects that it comes in contact with. Depending on the weather conditions or altitude, the air pressure can vary over a small range. The standard atmospheric pressure, which corresponds to the typical pressure at sea level, is defined as the pressure sufficient to support a column of mercury (Hg) 760 mm in height. This pressure, 1.01×10^5 Pascals (Pa) or 1.01×10^3 Millibar (mBar) is used to define another unit in common use, the atmosphere (atm). The international system of units for pressure is the Pascal.

1 atm = 760 mm Hg = 1.01×10^5 Pa

One mm Hg pressure is also referred to as a Torr after the Italian scientist Torricelli (1608-1647), who invented the barometer.

1 mm Hg = 1 Torr
1 micron Hg = 1×10^{-3} Torr

Depending on the application or the country where you live, you may be familiar with one or more pressure units. Table A-1 provides a useful summary of the correlation between the following pressure units: Atmosphere, Torr, Millibar, Pascal and Micron.

A vacuum is any pressure less than atmospheric pressure. Vacuums that are termed low, moderate, high, and ultra-high have pressures that range from a fraction of an atmosphere to 10^{-8} Torr and below. A high vacuum system is usually considered to have a pressure of 10^{-3} Torr (1 micron Hg) or lower.

A vacuum system is a closed volume that is isolated from the air pressure outside by the walls of the vacuum components. The vacuum system is evacuated by the use of vacuum pumps that transfer the gas from the inside of the vacuum system to the outside.

Systems capable of producing a high vacuum environment are used for a variety of useful tasks. To accomplish these tasks, the vacuum system must be capable of maintaining a pressure low enough to perform the desired process, while minimizing the effects of background gas pressures.

Table A-1 provides a convenient summary of pressure unit equivalents for the pressure units currently used throughout the world.

Table A-1. Units of Pressure Measurement

	Std Atm	Torr	Millibar	Pascal	Micron
1 Standard Atmosphere	1	760	1,013	101,325	7.60×10^{5}
1 Torr = 1 mm Hg	1.32×10^{-3}	1	1.33	133	1000
1 Micron = 10^{-3} mm Hg	1.32×10^{-6}	1×10^{-3}	1.33×10^{-3}	0.133	1
1 Millibar (mBar)	9.87×10^{-4}	0.75	1	100	133
1 Pascal = 1 Newton per M^2	9.87×10^{-6}	7.5×10^{-3}	10^{-2}	1	1.33

A.2 Contamination of a Vacuum System

If all of the gas to be removed from a vacuum chamber were located in the volume of the chamber, it could easily be removed by the vacuum pump system in a short time. Unfortunately, gases, liquids and solids stick extremely well to the internal walls of a vacuum system. These materials all have their respective vapor pressures and provide a continual source of material that is observable with the QualiTorr Remote as the background contamination level. This is why vacuum systems must be continually (dynamically) pumped. These gases are constantly being released (desorbed) from the vacuum components themselves.

Typical contaminants in a vacuum system include the pump oil from the mechanical pump, water from the air, and grease from human fingerprints. A fingerprint has a typical out-gassing rate of 10^{-5} Torr-liters per second and produces 100,000 liters of volatiles per second at a system pressure of 10^{-10} Torr.

Baking the vacuum system increases the temperature and vapor pressure of the contaminants to increase their rate of desorption from the internal vacuum system surfaces. Baking vaporizes the contaminants from the walls of the vacuum components so that they can be swept through the turbomolecular and mechanical pumps and out of the system using the flushing gas. When the temperature is reduced at the end of the system bakeout, the amount of contamination and its corresponding vapor pressure will be significantly reduced. This is easily confirmed by evaluating QualiTorr Remote spectra from before and after a system bakeout.

A.3 Handling and Cleaning Vacuum Components

Certain QualiTorr Remote installation and maintenance procedures require that the user handle vacuum components, such as the probe and Conflat flanges, that have surfaces that are normally within the vacuum system during operation. As a result, these surfaces must be treated with special respect and care to minimize the amount of contamination they are exposed to while they are in a hostile environment. Here are the few simple rules to assist in maintaining a clean vacuum system.

1. **Never touch a vacuum surface with your hands or any part of your body. The grease that is transferred will become a contributor to the background contamination of your vacuum system. Use plastic or rubber gloves.**

2. **Never touch a vacuum surface with any tool that has not been thoroughly degreased (see Rule 6 for the recommended cleaning procedure).**

3. **Never touch a vacuum surface with a material that transfers lint or dust.**

4. **Never use compressed air to blow on a vacuum surface, unless the air has been processed or filtered to remove oil and grease.**

5. **Always use clean plastic or rubber gloves to handle vacuum components. Disposable gloves are the best, but don't use the type that use powder to make putting-them-on and taking-them-off easier. A contaminated glove is just as bad as using a bare-hand. Consider all vacuum surface manipulations as surgical operations in which the patient will die if contamination occurs.**

6. **If contamination of the vacuum surface does occur or is suspected, use a high quality of acetone (reagent grade or better) to remove the grease followed by a methanol or ethanol (reagent grade or better) rinse. Cotton swabs or a lintless absorbant towel may be used to apply the solvents. Pour the solvent to be used into a separate clean container. Never apply the solvent from its storage bottle directly or pour the left-over solvent back into the solvent container; this will contaminate the entire bottle.**

7. **Conduct routine system bakeouts of your vacuum system. These can be done overnight or between process runs. Monitor the before- and after-bakeout contamination background level using the QualiTorr Remote.**

8. **Maintain a notebook to monitor the status of the vacuum system. Keep track of system use, log process gases and pressures used, record system bakeouts, and keep track of the background contamination level on a day-by-day basis.**

A.4 Notes on the Effects of Gas Flow on Sample Analysis

Gas flow characteristics constrain the proper use of a Residual Gas Analyzer (RGA) in the different stages of vacuum in typical applications. All users should be familiar with three basic types of gas flow when the gas pressure is reduced below the pressure of our atmosphere (760 Torr): viscous; molecular; and transitional.

A.4.1 Viscous Flow

Under viscous flow conditions, the individual atoms or molecules of gas bounce off each other much more often than the walls of the container. In other words, the mean-free-path (MFP) is very short compared to the dimensions (D) of the container (D > MFP). Under these conditions, gas molecules tend to flow together rather than individually, so the composition of a gas remains constant as it flows. Viscous flow exists when the pressure in a pipe or chamber (in units of microns or milliTorr, 1×10^{-3} Torr) multiplied by the diameter of that container (in centimeters) is greater than 500 micron-centimeters.

A.4.2 Molecular Flow

The movement of gases under molecular flow conditions is quite different than under viscous flow conditions. In this case, the mean-free-path of any two atoms or molecules is larger than the dimensions of the containing pipe or chamber (MFP > D). Again, in simple terms, when pressure (in microns or millitorr) is multiplied times the container dimensions (in centimeters), molecular flow conditions exist if this product is less than 15 micron-cm. The ionizers of all Residual Gas Analyzers operate under these conditions and it is important to recognize that all atoms or molecules bounce in random directions off the walls. This makes the wall surface very important. The speed of the gas flow is proportional to the mass of the particle and its energy ($E = 1/2mv^2$) and the direction of flow is random.

A simplified formula for calculating the mean-free-path (MFP) for air at 20°C is MFP (cm) = 4.86 cm/P (microns). This relation tells us that, at a pressure of one micron, MFP is 4.86 cm–close to the dimensions of most of the vacuum hardware we work with.

A.4.3 Transitional Flow

In the pressure region between (P x D) > 500 micron-cm and (P x D) < 15 micron-cm is a rather large transition range where neither viscous or molecular flow exists. The pressures and dimensions that correspond to this region are generally avoided to ensure compositional accuracy.

A.4.4 Adapting an RGA to the Proper Pressure

Nearly all applications fall into three general pressure regimes, and both open and closed sources can be adapted to each of these categories: very high and ultra-high vacuum; intermediate pressures; and high pressures. Each of these is discussed below.

Very High Vacuum (<1 x 10^{-5} Torr)

This pressure corresponds to a molecular flow condition in virtually any hardware. Since we are always interested in getting the best possible exposure of the ionizer to the gas of interest, in these applications the sensing probe is installed directly onto the experimental or process chamber. This type of application is generally used where contaminants from the walls or other residuals from the rest of the system are not a major concern, but rather gases which are not interfered with are of interest. The standard Open Source configuration operates best at pressures below 1 x 10^{-5} Torr. It is important to remember that in any Open Source operation the measured partial or total pressures become non-linear when the system pressure of 1 x 10^{-5} Torr is exceeded. Additionally, filament damage occurs (crystal slippage, or elongation) if the filament material is tungsten. Some typical VHV and UHV applications are: surface studies, MBE, evaporation, leak hunting, and a multitude of R&D areas.

Intermediate Pressures (10^{-4} to 10 Torr)

This pressure range covers applications such as sputtering, reactive ion etching, CVD, and others, where the pressure needs to be lowered for optimum ionizer operation. In the case of an Open Source, a single orifice on the inlet and a high vacuum pump on the probe is used to produce a pressure preferably around 5 x 10^{-6} Torr. Flow conditions in this type of inlet are molecular. The pressure is high enough to provide large amounts of the gases of interest without exceeding the 1 x 10^{-5} Torr limit. This conventional approach to sampling is limited by the background coming from the vacuum hardware itself. The base pressure of the high vacuum pump is likely to consist of large amounts of nitrogen, water, hydrogen, carbon monoxide, carbon dioxide, and oxygen and, to the extent that these gases do not interfere with gases of interest, this approach has had wide use.

UTI's innovative approach to sampling intermediate pressures, or for that matter high pressures, has been the introduction of the Closed Source in small systems to minimize the background limitation. The Closed Source Sampler also uses an orificed inlet and high vacuum pumping on the probe. The pressure for the specially designed **closed ionizer** is now optimized at **1 x 10^{-3} Torr**—several orders of magnitude above the otherwise limiting background levels.

High Pressures (150 to 1500 Torr)

This pressure range corresponds to a viscous flow condition. The UTI sampler converts this viscous flow condition to a molecular flow condition. Sampling in this pressure range utilizes a seriesed pair of orifices which are differentially pumped and a standard high vacuum pump on the probe. We refer to this type of inlet as an Atmospheric Pressure Sampling Module (APSM) and can configure the orifice sizes for either the Open or Closed Source geometries. Typical applications utilizing the APSM are: process gas monitoring, hazardous gas detection, high pressure CVD, gas laser studies, and a host of others.

In all UTI sampling hardware, special care is given to design the inlets to avoid mass discrimination. Since in all cases pressures in the ionizers must be in molecular flow, disproportionately attenuated flow of the heavier masses would be the natural consequence of pressure reduction. This is compensated for by appropriate downstream instrument design.

Appendix B

Orifice Selection

This appendix provides a guide to the selection of pressure-reduction orifices for use with the QualiTorr Remote inlet sampler system and closed source probe configuration.

B.1 Introduction

UTI has developed a line of samplers that use pressure-reduction orifices to provide a solution to the apparent problem caused by the following statements:

Most mass spectrometers work best with their major elements at pressures **below** about 10^{-5} Torr. An exception is the ionizer portion of the closed source probe, described below.

Most process fabrication processes are conducted at pressures **above** 10^{-5} Torr.

To solve this apparent problem, a procedure is used to transfer the process gases at high pressures into the QualiTorr Remote at pressures which are optimum for its operation.

The UTI "Two-Stage Sampling" method employs two steps of pressure reduction: The first step consists of the gas passing through a fixed orifice between the process chamber and the entrance to a "Closed Source" (patented). The second step consists of the passage of the gas through three orifices in the ion source. The correct selection of the first (entrance) orifice will reduce a wide range of process pressures to pressures in the Closed Ion Source ranging between 10^{-4} to 10^{-3} Torr. This is the optimum pressure range for this source. The exit orifices of the source and the pumping of the TMP will further reduce the pressures in the remaining quadrupole structure to about 10^{-6} Torr.

Open source sampling systems are designed to optimize the probe pressure in the 10^{-6} Torr region, but not above 10^{-5} Torr.

B.2 Orifice Selection

Selection of the correct entrance orifice can be done by UTI, based upon information from the user regarding the intended operating pressure(s) in the process chamber. From one to four different entrance orifices and valves can be produced in a single-inlet configuration so that one can select up to four different ranges of process pressures. However, the user may wish to know how these orifices can be selected and to select some additional sizes in order to experiment and optimize sampling parameters.

This appendix explains how to select entrance orifices to be used with the UTI Closed Source so as to obtain optimum sensitivity and linearity in signal response. Figure B-1 provides the simplest means of selecting the most appropriate orifice(s). To select an orifice follow these steps:

1. Find the particular Process Chamber Pressure(s) you will be using on the abscissa (horizontal or X axis.

2. From this point on the abscissa, read vertically up the chart to the region between 10^{-4} and 10^{-3} Torr for the Source Pressure. Find an orifice size in mils (1 mil = 0.001 in = 0.0254 mm) which is between 4×10^{-4} and 8×10^{-4} Torr. **This is the optimum orifice diameter for use with that particular process chamber pressure.**

3. All inlets are made with a Main Conductance Valve, which has a limiting conductance of about 0.5 liters /second, and is also shown in Figure B-1.

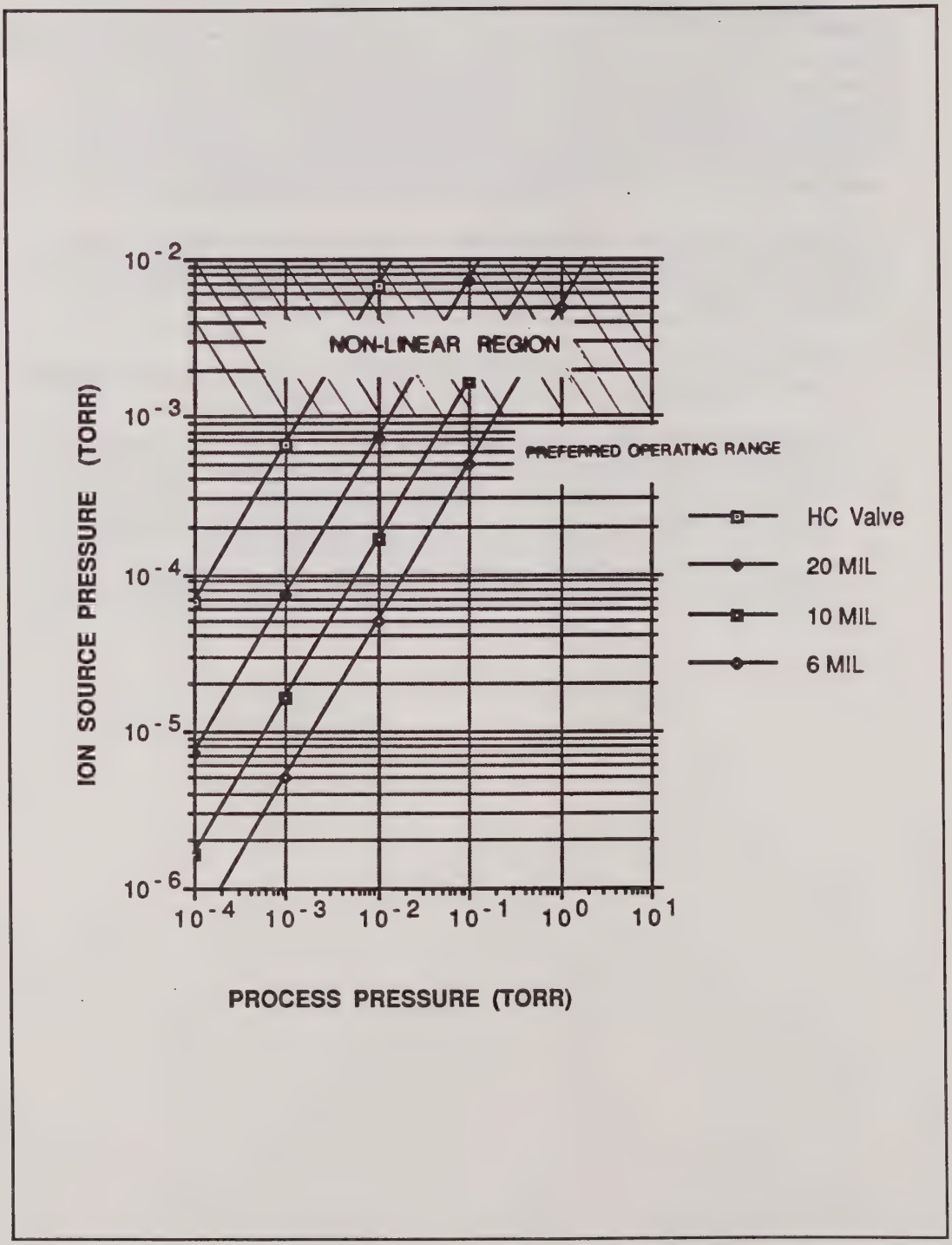


Figure B-1. Ion Source Pressure vs. Process Pressure for Various Orifice Diameters

B.3 Multiple Pressures and Orifices

If one has two or more operating pressures different by a decade or more, and also wishes to observe his process chamber at high vacuum conditions, a 3PSM inlet can be used which employs two orifices and one Main Conductance Valve. For example, if two process pressures were 100 microns (0.1 Torr) and 7 microns (0.007 Torr), the two orifices of 6 mils and 20 mils, as shown on the chart, would be most useful. Other examples may be chosen which would require orifice sizes not shown here, but are available from UTI.

B.4 Evenly-Spaced Orifice Differences

It may be advantageous and more convenient to have inlets which differ by factors of ten from each other in their gas flow and hence pressures. It is possible to do so by properly sizing the orifices relative to each other and to the Main Conductance Valve. Such an arrangement is depicted in Figure B-2, wherein orifices of 19, 6.75, and 2.8 mils are used with the Main Conductance Valve to give pressures differing by one decade from each other.

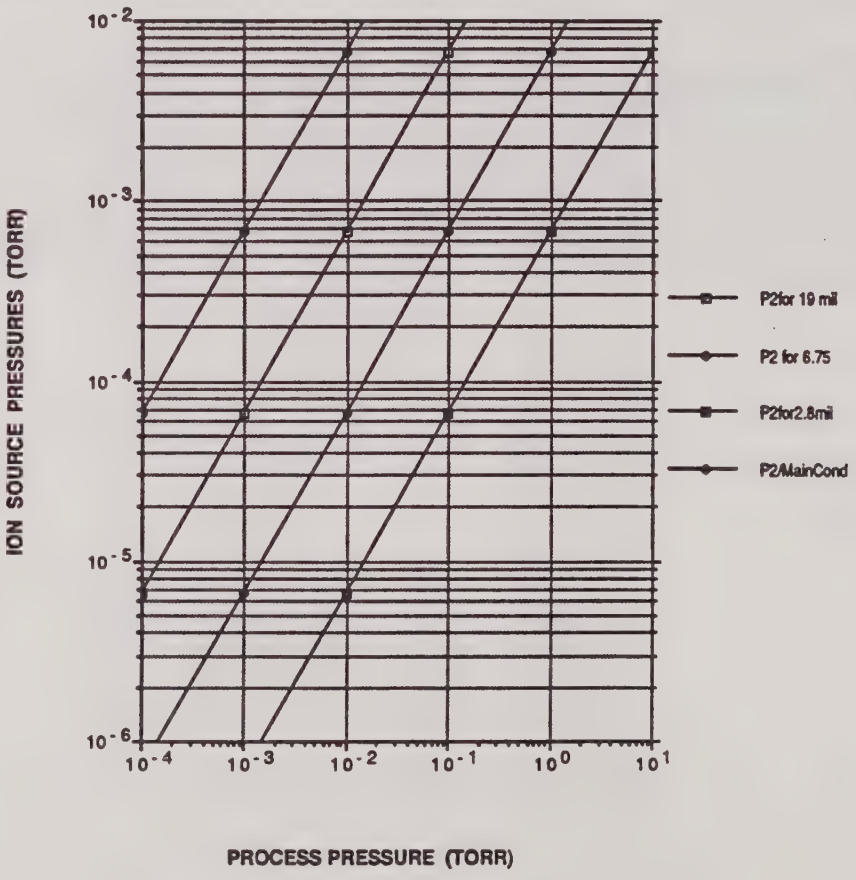


Figure B-2. Ion Source Pressure vs. Process Pressure for Orifices with X10 Conductances.

B.5 Orifice Conductance Calculations

For further edification, the method of determining the conductances of the various orifices is shown in Figure B-3 and Table B-1.

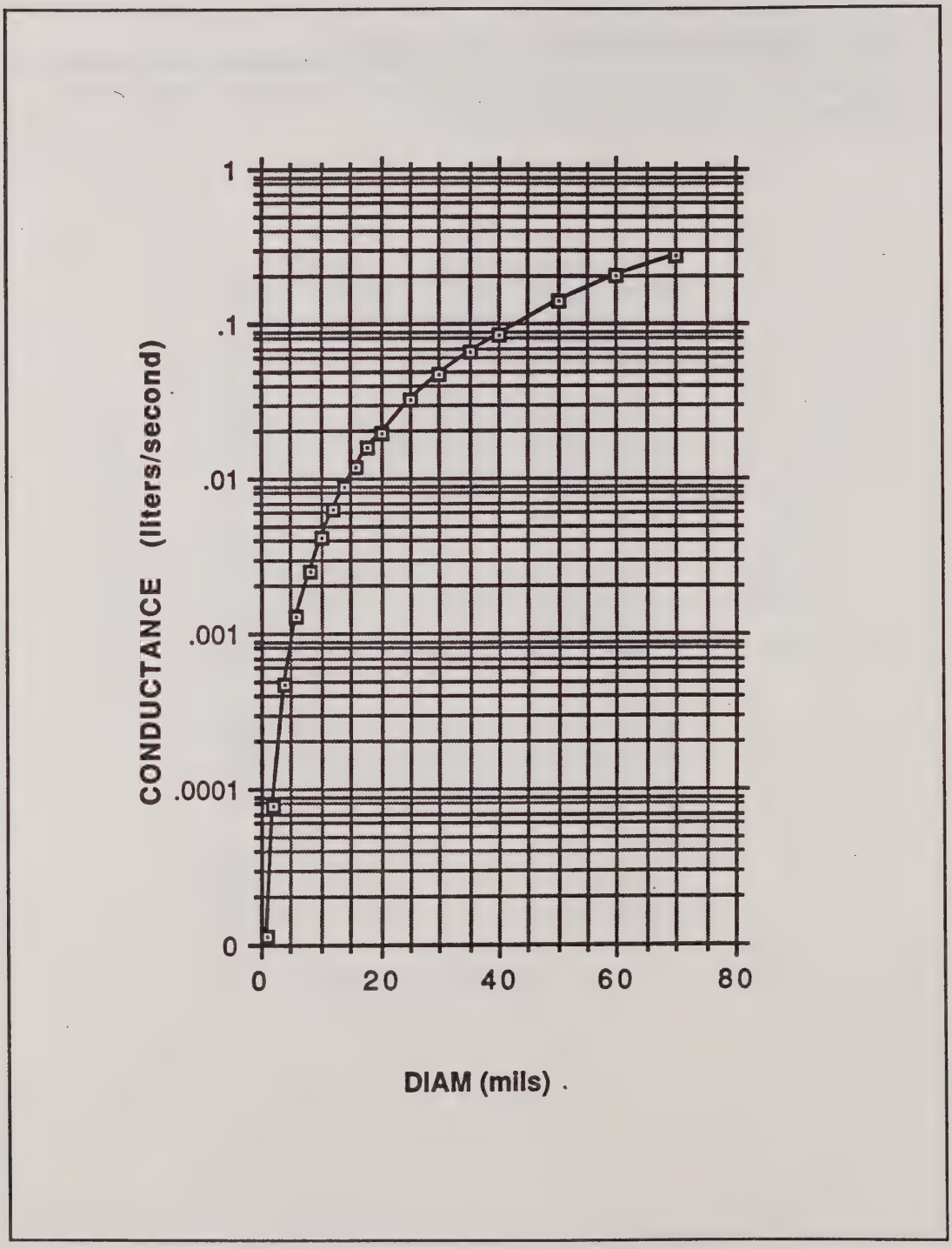


Figure B-3. Conductance vs. Orifice Diameter

Table B-1. Orifice Conductance Calculations

ORIFICE CONDUCTANCE CALCULATIONS

	A	B	C	D	E	F	G	H
1	DIAM. (MILS)	a=RAD'S(CM)	AREA=pi*a^2	t/a=.014/a	K'=(1+3/8t/a	C=11.7*A/K'	P2/P1=C1/(C	P1=PROC.PR.
2	1	1.27E-03	5.07E-06	1.10E+01	5.13E+00	1.15E-05	4.82E-05	0.0001
3	2	2.54E-03	2.03E-05	5.51E+00	3.07E+00	7.73E-05	3.09E-04	0.001
4	4	5.08E-03	8.11E-05	2.76E+00	2.03E+00	4.66E-04	1.86E-03	0.01
5	6	7.62E-03	1.82E-04	1.84E+00	1.69E+00	1.26E-03	5.03E-03	0.1
6	8	1.02E-02	3.24E-04	1.38E+00	1.52E+00	2.50E-03	9.91E-03	1
7	10	1.27E-02	5.07E-04	1.10E+00	1.41E+00	4.19E-03	1.65E-02	10
8	12	1.52E-02	7.30E-04	9.19E-01	1.34E+00	6.35E-03	2.48E-02	
9	14	1.78E-02	9.93E-04	7.87E-01	1.30E+00	8.97E-03	3.46E-02	
10	16	2.03E-02	1.30E-03	6.89E-01	1.26E+00	1.21E-02	4.60E-02	
11	18	2.29E-02	1.64E-03	6.12E-01	1.23E+00	1.56E-02	5.88E-02	
12	20	2.54E-02	2.03E-03	5.51E-01	1.21E+00	1.97E-02	7.29E-02	
13	25	3.18E-02	3.17E-03	4.41E-01	1.17E+00	3.18E-02	1.13E-01	
14	30	3.81E-02	4.56E-03	3.67E-01	1.14E+00	4.69E-02	1.58E-01	
15	35	4.45E-02	6.21E-03	3.15E-01	1.12E+00	6.50E-02	2.06E-01	
16	40	5.08E-02	8.11E-03	2.76E-01	1.10E+00	8.60E-02	2.56E-01	
17	50	6.35E-02	1.27E-02	2.20E-01	1.08E+00	1.37E-01	3.54E-01	
18	60	7.62E-02	1.82E-02	1.84E-01	1.07E+00	2.00E-01	4.44E-01	
19	70	8.89E-02	2.48E-02	1.57E-01	1.06E+00	2.74E-01	5.23E-01	
20	19	2.41E-02	1.83E-03	5.80E-01	1.22E+00	1.76E-02	6.57E-02	
21	8.75	8.57E-03	2.31E-04	1.63E+00	1.61E+00	1.88E-03	6.66E-03	
22	2.7	3.43E-03	3.69E-05	4.08E+00	2.53E+00	1.71E-04	6.83E-04	
23	95	1.21E-01	4.57E-02	1.16E-01	1.04E+00	5.13E-01	6.72E-01	

Table B-1 Continued. Orifice Conductance Calculations

ORIFICE CONDUCTANCE CALCULATIONS

	I	J	K	L	M	N	O	P	Q
1	P2 FOR 6 MIL	P2 for 10 mil	P2 for 20 mil	P2 for Mn.Col	P2 FOR 19	P2 for 6.8	P2 for 2.7	P1=PROC.PR.	
2	0.000000502	0.00000165	0.00000729	6.67E-05	0.0000667	6.67E-07	6.67E-08	0.0001	
3	0.00000502	0.0000165	0.0000729	6.67E-04	0.0000667	0.00000667	6.67E-07	0.001	
4	0.0000502	0.000165	0.000729	6.67E-03	0.000667	0.0000667	0.0000667	0.01	
5	0.000502	0.00165	0.00729	6.67E-02	0.00667	0.000667	0.000667	0.1	
6	0.00502	0.0165	0.0729	6.67E-01	0.0667	0.00667	0.00667	1	
7	0.0502	0.165	0.729	6.67E+00	0.667	0.0667	0.00667	10	
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Appendix C

Using Calibration Gases

This appendix provides a brief introduction to the calibration of the QualiTorr Remote using only a single gas or a single gas and the UTI Cal-Gas mixture, rather than using only the UTI Cal-Gas mixture.

C.1 Introduction

In many instances in the customers facility, it is not feasible to use UTI's *Cal-Gas Mix* for calibration. In some cases, inletting significant amounts of the UTI *Cal-Gas Mix* will flood or overwork the cryopumps, because of the relatively high amounts of hydrogen and helium in the Cal-Gas. Therefore, UTI has provided the means to RE-calibrate (after initial factory calibration) the QualiTorr Remote using some of the normal process gases, namely: nitrogen, argon, C_2F_6, and CHF_3.

The procedures for calibrating to any of these gases by the operator is essentially the same as used for the UTI Cal-Gas. However, the internal operation of the calibration routines is not the same in all instances. These operations will be explained in the following sections.

C.2 Calibration Using a Single Gas (Local Mode)

When CALIBRATE is selected from the main menu monitor screen, the operator is given the choice of five (5) gases from which to choose: UTI Cal-Gas; nitrogen, argon, CHF_3 or C_2F_6. After choosing any one of the gases, the same procedures are followed as explained in Section 6.12 of this manual. The CRT screen then informs the operator as to which mass peaks (AMU) -- corresponding to a specific molecular fragment -- are being used during each step of the location function, just as with the Cal-Gas. Sensitivity calibration procedures are also the same, wherein the operator is asked a second time about the pressure of the gas in the process chamber. The then proceeds to adjust the electron multiplier high voltage (EMHV) so as to give the correct peak heights for the gas under calibration. The readouts on the monitor are the same as those described in Chapter 4.

Table C-1 shows the single calibration gases, the M/e values of the detected ions, and the chemical formula for the atomic or molecular ion fragments. Note that AMU = M/e for single charged ions.

Table C-1. Single Calibration Gases

Single Gas	M/e	Fragment
Hydrogen	2	H_2^+
Nitrogen	14	N_1^+ and N_2^+
	28	N_2^+
	42	N_3^+
Argon	20	$Ar(40)^{++}$
	40	$Ar(40)^+$
CHF_3	31	CF^+
	51	CF_2^+
	69	CF_3^+
C_2F_6	12	C^+
	19	F^+
	31	CF^+
	50	CF_2^+
	69	CF_3^+
	119	$C_2F_5^+$

The *peak location* for the Single Gas includes the usual interpolation via slope and intercept for the peaks between those listed, **but no extrapolation is done for peaks outside the upper and lower limits of those listed in Table C-1.** The locations established during the original factory calibration or during any subsequent stored Dynamic Scan are maintained in the Calibration Table. Therefore, it is advisable to run an Dynamic Scan with peaks selected other than those within the calibration domain in order to increase the assurance of accurately tracking those *peripheral peaks*.

The internal sensitivity calibration function changes the sensitivity coefficients for the particular peaks listed in Table C-1 to correspond to the known *Fragmentation Patterns* and then modifies the EMHV to bring the major peak of the particular gas to read the appropriate value corresponding to the operator input. **No other interpolation is done on other sensitivity coefficients in the Calibration Table, so the other coefficients remain as in the factory calibration.** This completes the description of the Single Gas Calibration Procedure. However, if there is the possibility of using *both* the UTI Cal-Gas *and* a Single Process Calibration Gas, a 3-part calibration is recommended. This procedure is described in Section C.3.

C.3 Calibration Using Both the UTI Cal-Gas and a Single Gas

If both the UTI Cal-Gas and a Single Process Gas is available, a 3-part calibration routine is recommended wherein the Single Process Gas Calibration is performed first, as described in Sections C.1 and C.2. Then, the UTI Cal-Gas is introduced carefully until the AMU 28 peak is raised to the same CRT read-out level as the Single Process Gas while the operating pressure is at the same previous level. This can be performed by using Dynamic Scan to monitor the six peaks in the UTI Cal-Gas and slowly raising the AMU 28 peak to the desired level. Then, the system is put through the same Calibrate function as always, and the Calibration Table is saved to disc. To complete the 3-part calibration, the is then RE-calibrated a third time using the same Single Process Gas as used in the first step. This leaves the in the highest and most accurate state of calibration possible for the single process gas.

C.3.1 UTI CAL GAS - Nitrogen Carrier - With Helium

You can perform a calibration on the QualiTorr Remote to

- Set overall analyzer sensitivity so the Torr scales read correctly.
- Locate selected mass peaks to find the optimum point on each peak top for taking data.

You can use the UTI CAL-GAS mixture to provide calibration of sensitivity response of individual gases. This provides the best accuracy for the mass areas calibrated. UTI CAL-GAS is: 1% each of hydrogen, helium, argon, krypton, and xenon in a balance of nitrogen (95%). Inclusion of krypton and xenon allows:

1) mass location calibration over a wider range

2) mass roll-off correction.

Calibration should be performed periodically. Currently, we recommend once per quarter.

C.3.2 UTI CRYO CAL GAS - Argon Carrier - Without Helium

You can perform a calibration on the QualiTorr Remote to

- Set overall analyzer sensitivity so the Torr scales read correctly.
- Locate selected mass peaks to find the optimum point on each peak top for taking data.

This calibration gas consists of 1% each of: hydrogen, nitrogen, krypton, and xenon, with the balance of argon (96%). Helium is specifically eliminated for use with cryopumping.

Appendix D

Local Mode Operating Instructions

This appendix provides QualiTorr Remote Local Mode operating instructions for Maintenance Calibration and for the Process Programmer and Process Operator.

D.1 Local Software

The Host has the ability to create a Local diskette. ***If you desire to operate in the Local Mode***, this disk will simulate the operation of a QualiTorr III console. To create a Local disk:

1. Boot the Host computer. Wait for the date prompt.
2. Press "c" while holding "<Ctrl>" down.
3. Then type "y" to terminate the batch job.
4. Type "CD QTREMOTE <Enter>". At completion, you will find yourself at the "C:\QTREMOTE>" prompt.
5. Place a blank disk (either high density, or low density, as indicated below) into the drive of the Host computer. Reformatting is a part of this copy process.
6. Now type "format a: /f:1.44 /s <Enter>" (if the disk being used is the High Density type, or, "format a: /f:720 /s <Enter>" if the disk is the Low Density type).
7. Type "mk local <ENTER>". The Host will transfer the required files onto the disk.
8. Remove the disk from the Host, insert it into the Remote Station Controller of interest.
9. Turn the Remote Station Controller OFF and make sure the monitor and keyboard cables have been transferred to the Remote Station (front of console).
10. Re-boot the Controller by turning it back ON.

Recall that the six vertical menu selections are now chosen by the keyboard function keys F1 - F6 starting from the top of the screen downward. Also, L = Leave (Exit), K = Key (Switch), and D = Delete (Cancel).

D.2 UTI Qualitorr Remote Startup - Shutdown Check List

I. Startup of Vacuum System Controller (VSC)

1. Initialize Vacuum System Controller

   a) Power breaker on VSC front panel ON
   b) System Power button ON

2. Pump Start/Stop on VSC On

   a) Within 5 minutes, top 4 LEDs should be ON, Turbopump Purge OFF.

3. Vacuum Gauge 1 (Foreline) should be reading < 25 mTorr.

4. Inlet Pressure gauge should be < 10 MTorr (if process operates < 10 MTorr).

5. Verify pneumatic valves have 110-120 psi operating pressure.

II. Startup of QualiTorr Remote Electronics

1. Turn ON Host Computer and Monitor; wait for bootup.

2. Turn ON Remote Console; wait for bootup.

System operation can begin.

III. Shutdown of QualiTorr Remote Electronics

1. Select SHUTDOWN in Systems menu of QualiTorr Remote Host Computer.

2. If long term shut-down is desired (> 1 week), turn OFF Host Computer and Remote Controller.

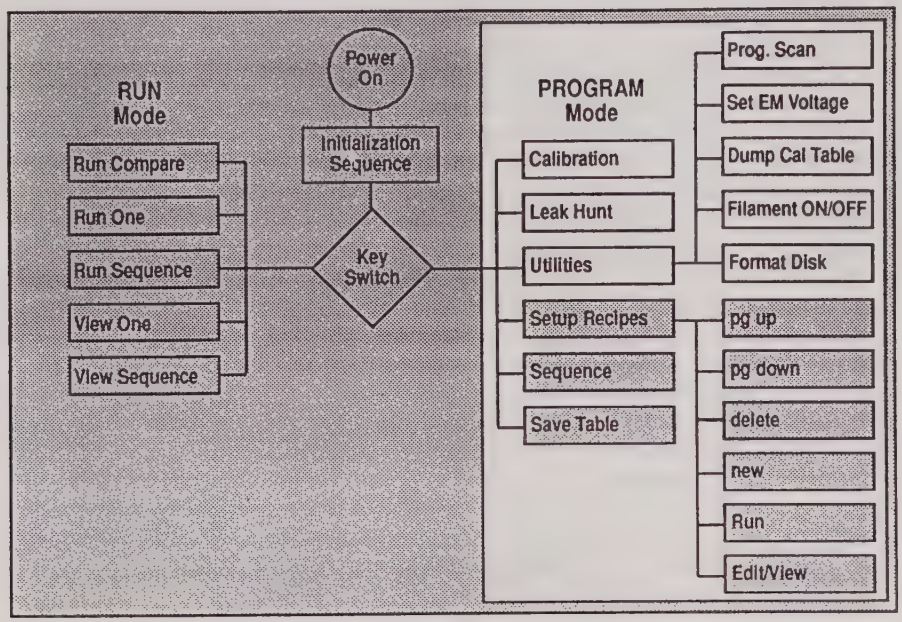
3. Turn OFF Vacuum System Controller breaker (valves will close and pumps will stop).

Note: It is usually preferred to have the probe chamber, and the vacuum system associated with it, operating even if the QualiTorr Remote is not in use on the process chamber. This helps to assure vacuum cleanliness. It is also common to leave the QualiTorr Remote electronics ON (with filaments operating); in this event, any Scan, Calibration, or Leak Hunt program should be Stopped and Closed.

QUALITORR SHORT MANUAL INSTRUCTIONS

Using Software V3.2

FOR MAINTENANCE AND CALIBRATION (Key in PROGRAM position)



I. INITIAL START-UP CONDITIONS

A. Be sure all pumps are operating and are valved in. Check the thermocouple gauge on the turbo pump foreline and make sure it is below 100 milliTorr. Higher pressures could indicate the need for an oil change in the mechanical forepump, excessive gas entering the probe inlet, sieve trap bakeout, or if visably coated, replacement of the sieve material.

B. If you are using a Sampler (orifices) to drop process pressures at the sensing probe, verify that the proper orifice is valved in. ***The High Conductance Valve is used only when the process pressure is $<2x10^{-3}$ Torr (Closed Source), $<1x10^{-5}$ Torr (Open Source).***

C. Sometimes process chambers have additional valves on the gas sampling line. ***Be sure the entire sampling line is evacuated before opening any of the Sampler valves,*** to avoid sending a burst of high pressure into the filament region of the probe.

D. Turn the power switch ON.

1. Press BEGIN WARMUP and follow the instructions.
2. After the 10 minute warmup, control passes to RUN or PROGRAM. Be sure key is in PROGRAM position.
3. If the Filament Protect circuitry has been tripped, a FILAMENT status light on the front of the console (near the keys) will flash ON and OFF. It is reset by turning the QualiTorr console OFF, then ON again. If filaments have been burned out, the status light will stay ON continuously. Normally the light is OFF. When power is applied to the filaments (even if filaments are faulty) a FILAMENT POWER ON status is displayed in the middle of the screen immediately following the RAMPING FILAMENT VOLTAGE message. After power is turned ON, or the system is re-booted, the filaments will always automatically be turned ON (default condition), even if, before shutting down, they had been turned OFF in the PROGRAM UTILITIES mode.
4. At the top of the PROGRAM menu a table will list the Probe No. (P#) (some systems have multiple probes), and File Type (T), i.e., Static (S) or Dynamic (D).

OVER

II. SYSTEM CALIBRATION (each probe *must* be calibrated)

A. If your software handles more than one probe, enter 1-8 to SELECT a PROBE; no selection is necessary for single probe operation.

B. Press CALIBRATE on the screen. (For details see the QualiTorr Installation & Maintenance Manual, Appendix C and D.)

C. Select the gas you will be using for calibration. (It *must* be one of those listed.)

1. ***Be sure the correct inlet valve (orifice) is being used*** to avoid abuse of the filaments.

a) Adjust the Cal Gas pressure in your process chamber, or Calibration Cart, to approximate process operating pressures (within a decade if possible). ***Adding this gas can be skipped if the instrument is not going to be sensitivity calibrated.***

D. Press LOCATE PEAKS... to do Mass Location Calibration. Note: *Mass Location Calibration can be done on detectable background peaks as long as they are listed as Cal Gases (NITROGEN for example).* Peaks need to be present for the calibration to take place.

E. Press SENSITIVITY CALIBRATION (for quantitative accuracy), or EXIT (See G.1.,2.,3.)

1. Enter the maximum *operating pressure* that you wish to view on the screen via the numerical keypad (all three digits of the scientific notation must be entered).
2. Now enter the ***precise*** pressure of the Cal Gas. ***To get extended sensitivity, (say X10), maximum pressure viewed can be set ten times lower than the calibration pressure (for easier viewing of trace levels; calibration is still valid).***

F. Press OK; *absolute* peak height values (determined by electron multiplier final voltage), and *relative* peak values (sensitivity coefficients) will be updated. The Total Pressure scaling factor for Dynamic runs is also determined at this time.

G. Press one of 3 EXIT choices...

1. EXIT by SAVING the NEW CALIBRATION TABLE (Each probe **must** be calibrated),
2. EXIT by DISCARDing the NEW TABLE (reverts to previous calibration table), or,
3. EXIT by RESETting TO NOMINAL (theoretical) VALUES.

H. You are now back to the PROGRAM MODE Main Menu.

III. LEAK HUNTING (See Sec. 4, p51 of Installation & Maintenance Manual for details)

A. Press LEAK HUNT to search for system leaks.

1. Select a gas for the Process Monitor to respond to for leak hunting.
2. Adjust the valves appropriately for the pressure in the process chamber (high conductance open for high vacuum, etc.; ***high vacuum is best for leak hunting***).
3. Press CONTINUE and proceed to leak hunt.
4. When system fills with leak hunting gas, set a new threshold as necessary.

IV. UTILITIES

A. Press PROGRAMMABLE SCAN... for observing the quality of the instrument's scan, i.e., peak shape, height, resolution, and location. If manual adjustments are required, see *Adjustments* section (Sec. 6.0) of the Installation & Maintenance Manual for details. The vertical white line represents the theoretical position for the center peak. (The instrument can be manually adjusted to bring the middle of the peak to the white line.) The orange line is the last saved, calibrated position for that peak.

1. Press CENTER to put the peak of interest in the center of the screen.
2. Press WIDTH and enter the total number of companion peaks to be scanned.
3. Press FASTER to scan more quickly; BETTER scans slower with more precision.
4. Press ERASE to erase the screen for an automatic re-scan.
5. Press PRNT to copy the screen.

B. DUMP CALIBRATION TABLE...for print out of mass location DAC values, nominal (NDV) and calibrated (CDV), as well as sensitivity coefficients, nominal (NKM) and calibrated (CKM).

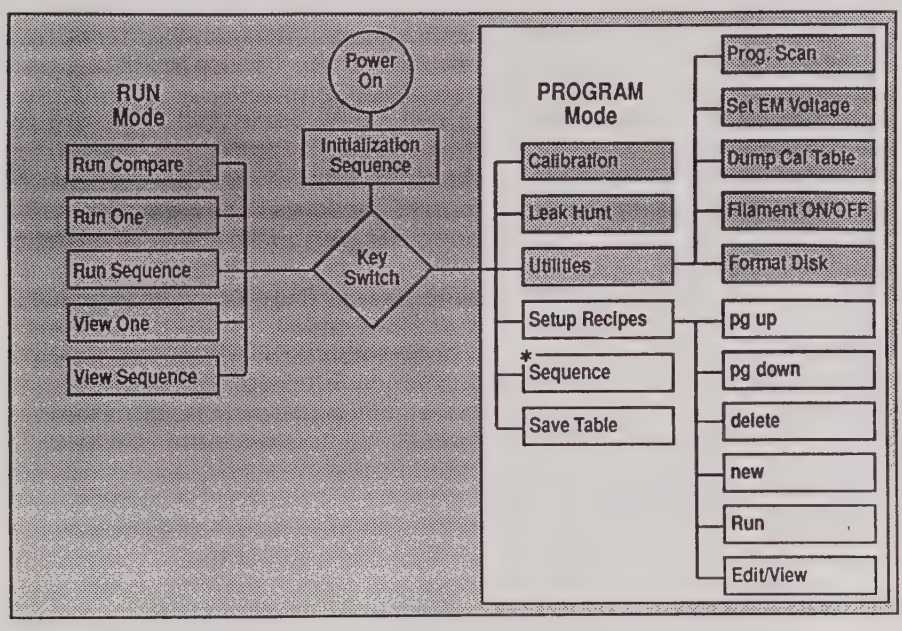
C. SET MULTIPLIER VOLTAGE... allows keypad entry of any multiplier high voltage up to 3000V maximum. ***This overrides the value obtained in the sensitivity calibration.*** Typical practical operating values will run from 700 to 3000V.

D. SET FILAMENTS OFF...will turn filaments OFF when pressed, and SET FILAMENTS ON will turn filaments ON when pressed.

E. FORMAT DATA DISK... is always necessary prior to the use of a new disk. ***Note, this action will erase all old files on the disk being formatted.***

QUALITORR SHORT MANUAL INSTRUCTIONS
Using Software V3.2

FOR THE **PROCESS PROGRAMMER** (Key in PROGRAM position)



I. INITIAL START-UP CONDITIONS (Read, also, INITIAL START-UP CONDITIONS in yellow *SHORT MANUAL FOR MAINTENANCE AND CALIBRATION.*)

A. Before turning on the Process Monitor, be sure all inlet plumbing is fully evacuated; only then should the equipment be operated.

B. Turn the power switch ON.

1. Key should be in PROGRAM position.
2. Press BEGIN WARMUP, allow 10 minutes, and follow the instructions on the screen.

II. PROGRAM MODE *Note: P# is Probe No., T is type of file, i.e, Static (S) or Dynamic (D).*

A. If your software handles more than one probe, enter 1-8 to SELECT a PROBE; no selection is necessary for single probe operation.

B. For CALIBRATE, LEAK HUNT, and UTILITIES... See *SHORT MANUAL FOR MAINTENANCE AND CALIBRATION.*

C. SETUP...presents a table of files (recipes) available for the currently active probe.

1. Use keypad to select from existing files. (For numbers < 10, enter zero first.)
   a) The highlighted file will automatically be used in the RUN MODE. See *SHORT MANUAL FOR THE PROCESS OPERATOR.*
2. Press PG UP/PG DN to view up to 100 files.
3. To delete an existing file, press DELETE, *this erases the entire file.*
4. Press NEW to create a new file.
   a) Press FILE TYPE to choose between Static (S) and Dynamic (D) files.
   b) Label NEW file by selecting numeric codes for each letter; corrections made with (C).
   c) Press OK when completed.

   If NEW file is Static (S), pressing OK returns to the previous menu.

   If the NEW file is Dynamic (D), pressing OK brings up the EDIT screen.

   - Use the keypad to change AMU, upper-lower limits, and process time.
   - Press UP, DOWN, LEFT, or RIGHT to move curser.
   - Press CHANGE ENTRY to turn a channel (peak) OFF or ON.

   (Note: Channels 7-10 *could* have options for monitoring EXTernal analog data. Minimum process time in Dynamic is 8 Sec., maximum is 1000 Hrs. Asterisk by formula identifies peaks used from UTI Cal Gas.)

*SEQUENCE is a feature of multiplexed systems, offered as an option for Auto-Mux operation. Sequence features are deleted in single probe system software.

OVER

5. Press RUN to manually collect new data to observe, or to save for future comparison.
   a) If the File Type for the chosen probe is Static (S), pressing RUN will offer the opportunity of scanning "pieces" of a spectrum, separated by commas, or a mass range, shown by a dash. (Example: 2,16-19,27-33,40) Pressing OK starts the scan.
   b) At the end of each Static RUN, data may be reviewed...
      - ZmX divides the horizontal axis into zones (1-4) for expansion; select a zone.
      - LINear toggles the vertical axis between linear or logarithmic units. In LINear ZmY is added; repeated selection of ZmY scales towards more sensitivity.
      - FUNCTion offers the choices of...
        - LIST, printing a tabular listing of the screen data,
        - PLOT, plotting the existing screen,
        - RUN (again), taking a new Static scan (if unsatisfied with previous scan),
        - RECALL brings back the most recently stored data in the same file and overlays it (yellow = same, red = reference data, and green = current data),
        - **SAVE, to store the existing scan** in place of the old scan, or,
        - CANCEL, returns to the previous menu.
   c) If the File Type for a chosen probe is Dynamic (D)... Peak location calibration will automatically take place for appropriate, pre-selected channels (peaks). Press START when lit, and observe data being taken in bar-graph form; this can be toggled to a time profile by pressing GRAPH, or DUAL to show both types of data at once.
   Note: Red Ball denotes peak height is outside limit window; L indicates no peak exists, or, for a measureable peak the instrument has not quite centered on it in the time allotted. This calibration, repeats periodically; L may disappear at a later time.
   d) At the end of each Dynamic (D) run data may be reviewed...
      - ZmY allows vertical scale expansion; enter zone No. (1-6) on the vertical scale.
      - ZmX allows horizontal scale expansion; enter zone No. (1-8) on horizontal scale.
      - AMU allows selection of specific profiles for examination; up to 10 at once.
      - FUNCTion allows you to PLOT (print) the screen, or, **SAVE it on the *hard disk. Note: tabular data goes to the printer live while data is being taken. Since bar-graphs are "momentary" in time, they are not saved.*** CANCEL returns to the previous menu.
   e) Press (E) to return to the previous menu.
   Note: You must SAVE new data before exiting (E) to permanently put it into a file for future comparisons.
6. Press EDIT/VIEW to change data collection parameters for new data, or view previously saved reference data.
   a) In viewing a Static (S) file, you will be presented directly with the data scan. You can vary the way this is VIEWed by following most of the steps listed in 5. c) above. Press CANCEL to return to the previous menu.
   b) In viewing a Dynamic (D) file you will be presented with an EDIT table. This allows you to see parameters of the previous run, or, you can modify these parameters. ***Note: Operating with a change of <u>any</u> parameter in this table will delete any existing scan data in the file in anticipation of a new run.***
      - Press UP, DOWN, LEFT, or RIGHT to move curser.
      - Press CHANGE ENTRY to turn a channel (peak) OFF or ON. (See II.C.4.c))
      - Press VIEW to review graphs associated with the set-up table in the Reference Files. *Note: VIEW appears only if data is available for viewing.* You can change the VIEW format by following the steps listed in 5. c) above.
   c) Press (E) to return to the previous menu.

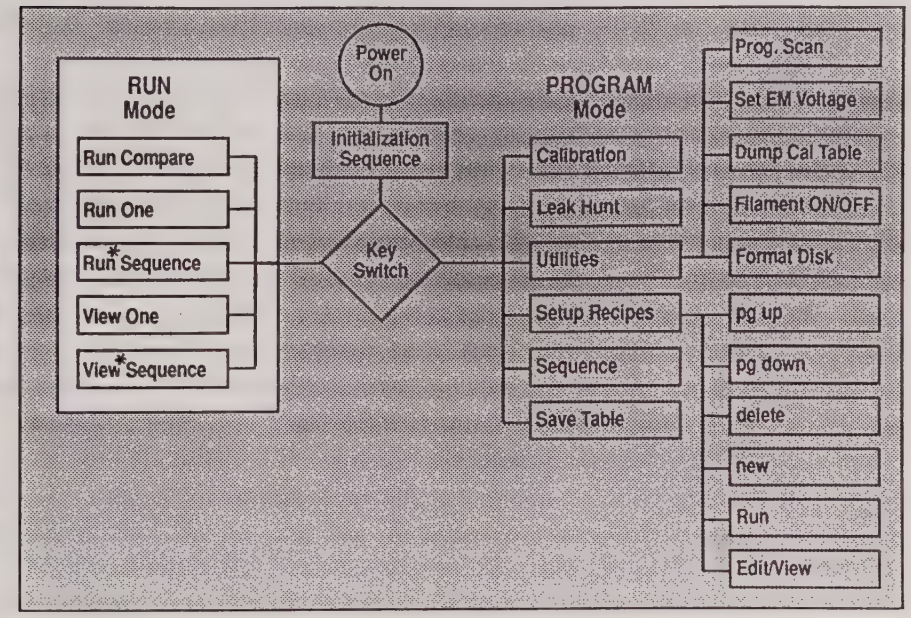
D. *SEQUENCE refers to the order (inside the brackets) in which different probes will be sequenced, or multiplexed, and the number before the brackets represents the number of sequences desired.

E. Press SAVE TABLE to assign the most recently selected files for each probe as the default files. Each time the process monitor is re-booted these files will appear for each probe.

*SEQUENCE is a feature of multiplexed systems, offered as an option for Auto-Mux operation.

QUALITORR SHORT MANUAL INSTRUCTIONS
For Software V3.2

FOR THE **PROCESS OPERATOR** (Key in RUN position)



I. INITIAL START-UP CONDITIONS (Read, also, INITIAL START-UP CONDITIONS in the yellow *SHORT MANUAL FOR MAINTENANCE AND CALIBRATION.*)

A. Turn ON power, wait for the automatic Boot-up.

B. If the key is in the RUN position, system will skip warmup and go directly to the last used probe and file that was pre-set in the PROGRAM position.

Note: If the system has been operating with the key in the PROGRAM position, press (E) repeatedly until reaching the top of the program menu, then switch key to the RUN position.

II. RUN MODE (Choose RUN COMPare, RUN ONE, RUN *SEQuence, VIEW ONE, or, VIEW *SEQuence) ***All data taken in the RUN MODE is automatically stored on the floppy data disk, ...up to 100 files for each probe.***

A. First choose a probe (P#); press 1-8 on the keypad. ***If system is not multiplexed, only one probe will show (no choice necessary).*** The options in the first displayed table were pre-programmed in the PROGRAM MODE. New runs can now be made *with the same set-up parameters* and compared to the reference runs, or just viewed. You will discover that a recipe associated with a specific probe can only be compared to new data on the ***same*** probe.

B. Choose RUN COMPARE to take new data and compare it to the reference (in PROGRAM). The display will show + or - deviations from the reference, up to a factor of ten.

1. If the pre-programmed File Type for the chosen probe was Static (S), pressing RUN COMPare will immediately start a new Static scan simultaneously comparing it to the reference for the system. The Static scan will run continuously.
2. If the File Type for a chosen probe was Dynamic (D)...
   a) Mass location calibration takes place for appropriate, pre-selected channels (peaks).
   b) Press START when lit, and observe data being taken and compared in bar-graph form; this can be toggled to a time profile by pressing GRAPH, or DUAL will show both displays simultaneously. *The Red Ball denotes that peak height is outside the programmed limit window; L indicates no peak exists, or, for a measureable peak*

*SEQUENCE is a feature of multiplexed systems, offered as an option for Auto-Mux operation. Sequence features are deleted for single probe system software.

OVER

the instrument has not quite centered on it in the time allotted. This calibration repeats periodically, L may disappear at a later time.

3. After the RUN COMPare data is taken, you may view the new data (RAW), or stored reference data (REF) and/or PLOT (print) any of the screens. If the compared data is Static, it will have the new file type designation SC; if Dynamic, DC.

C. Choosing RUN ONE allows data to be taken according to set up parameters for ONE selected probe in the PROGRAM MODE. (If system is **not** multiplexed, only RUN appears.)

1. If the pre-programmed File Type for the chosen probe was STATIC (S), pressing RUN ONE creates a new scan. Scan will be a colored, **overlaid** comparison to the reference, if one was saved in Program. (Yellow = same, red = reference data, and green = current data.) Note, for comparison to be valid, vertical scales should be the same.
   a) After the run is completed and stored, you can view it over the entire mass range, or by zones. Press ZmX, then the zone No. of interest for zoom expansion.
   b) Pressing LINear presents the vertical axis over a single linear decade. ZmY will now appear. Successively pressing ZmY changes the vertical axis by factors of 10 towards more sensitivity.
   c) Pressing LOG returns to the normal 6 decades of display. *Two additional decades (one at high end and one at the low end) are recorded in the tabular data.*
   d) FUNCTion permits printing of a tabular LISTing of data for the screen, or PLOT prints the screen as you see it. CANCEL returns to previous menu.
2. If File Type chosen is Dynamic (D)...
   a) Data taking begins immediately (parameters were set in the PROGRAM MODE).
   b) During operation, bar-graph or time profile GRAPHS can be viewed individually or together (DUAL) ...bar-graph shows only while data is being taken.
   c) At the end of the RUN the vertical axis can be expended with ZmY by selecting a region of interest (Zone No.) on that axis.
   d) ZmX allows horizontal scale expansion (if run time >60 sec.); enter zone No. (1-8) which will appear on the horizontal scale.
   e) AMU allows observation of any or all of the channels (peaks) that were pre-selected in the PROGRAM mode.
   f) FUNCTion provides the opportunity to PLOT the screen on the printer.

D. RUN *SEQuence (If your system has multiplexing capability) will commence the sequence of data taking defined at the top of the menu (pre-selected in the PROGRAM mode). Numbers ***in*** the brackets identify the probes that will be sequenced with the type of file previously designated. The No. before the brackets identifies the number of cycles for that sequence (up to 32,000!). Cycles are shown in the upper left hand corner of the screen.

1. VIEW *SEQuence will display a table of sequence sets taken.
   a) Now pressing VIEW shows a table of the files used in the sequence.
      o Select a File.
      o FUNCTion now presents NEXT or BACK to review individually stored cycles.

E. VIEW ONE allows viewing any stored reference data belonging to the selected probe. (If system is **not** multiplexed, only VIEW appears.)

1. PG UP or PG DN displays up to 100 files for selection.
2. NEXT PROBE selects the file table for each probe configured in your system.
3. VIEW directs you towards detailed examination of ***all*** the stored data on the floppy. (See C.1.a) through 2.e) above for steps in viewing.)

F. VIEW *SEQuence provides viewing of those files involved in the ***stored*** sequence.

1. Select a data file (sorted by probe No.).

Appendix E

Host Computer Operating Instructions

This appendix provides QualiTorr Remote Host Computer operating instructions.

E.1 QualiTorr Remote Software Upgrade Procedure

QualiTorr Remote software upgrades are contained in the files of the QualiTorr Host Upgrade disks. Installing the Host upgrade will also upgrade the master Remote files located on the Host.

After upgrading a Host Computer, all of the Remote Station disks will need to be upgraded also. The following is a description of how to accomplish this upgrade.

E.1.1 Host

1. Shut-down the Host System.
2. Insert upgrade disk into Host Computer.
3. Reboot (Restart, or Ctrl-Alt-Del).
4. Wait for upgrade process to complete.
5. Remove upgrade disk.

E.1.2 Remote Station Controller

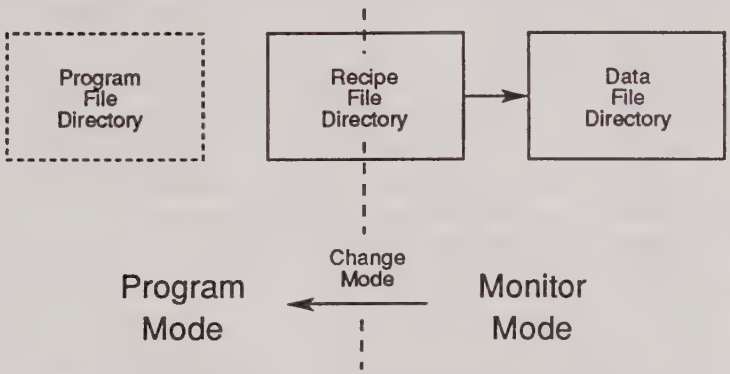
1. Remove the upgrade disk and reboot the Host Computer. At the "DATE" prompt, execute a Ctrl-C. The Host will ask if you wish to terminate the batch job. Answer "Y." You will be dropped out at the DOS prompt.
2. At the "C:\>" prompt type "cd qtremote." The prompt will respond with "C:\QTREMOTE>".
3. At this point, you are ready to upgrade the Remote Station Disks. Power down Station #1 and remove the disk from the Remote drive.
4. Place the disk from Station #1 into the drive on the QualiTorr Host Computer.
5. At the "C:\QTREMOTE>" prompt, type "format a: /f:1.44 /s <Enter>" (if the disk being used is the High Density type, or, "format a: /f:720 /s <Enter>" if the disk is the Low Density type).
6. Type "mk s1 <ENTER>". The upgrade will start for Station #1. At completion, you will again find yourself at the "C:\QTREMOTE>" prompt.
7. Stations 2, 3, 4, etc. should be upgraded by typing "mk s2", "mk s3", "mk s4", respectively, until all of the station disks have been upgraded. Make sure that you note the update information on each disk label.
8. Return each of the Remote boot disks to their respective drives and apply power to the Remotes. Reboot the Host computer and the new software will come up normally.

See instructions in Appendix D for creating a **Local** diskette from the Host Computer.

QUALITORR REMOTE
HOST COMPUTER OPERATING INSTRUCTIONS
MONITOR MODE OVERVIEW

Monitor Mode functions under the *System* menu allow you to determine the QualiTorr Remote software version number, *Copy* Data Files, *Delete* Data Files, configure the QualiTorr Remote *Network, Change Mode* to Program Mode, and *Shutdown.*

Monitor Mode functions under the *Station 1, 2, 3, 4, or 5* menus are used to select and *Run* recipes already listed in the Recipe File Directory. The Recipe File Directory is created in *Program Mode.* Gas analysis recipes that have been *Run* in *Monitor Mode* write new data files that are automatically stored in the Data File Directory. Choosing *Open* allows you to select and review previous runs stored in the Data File Directory and to control the screen display of the data by the use of the Arrange, Axis, Channel, and View functions. These and other Monitor Mode functions are described on the back side of this page.



System Menu In Monitor Mode		
Function	Description	Active/Inactive
About Quali-Torr Remote	Displays UTI's copyright notice, the version number of the QualiTorr Remote software, and UTI's address and telephone number.	Active at all times.
Copy Files	Copies Files from the Data File Directory to a floppy disk.	Active at all times.
Delete Files	Deletes a selected file from the Data File Directory.	Active at all times.
Preferences	Allows naming Host and Station, choosing a password, and locking out inactive Stations.	Active at all times.
Network	Select which Remote Stations are to be active on the QualiTorr Remote Network.	Active at all times.
Change Mode	Initiates (toggles) a *Change* between *Monitor* and *Program Modes.*	Active at all times.
Shutdown	*Shutdown* terminates QualiTorr Remote communication with all Stations on the Network. *Shutdown* must be selected before turning the Host Computer and/or Station Controller Off.	Active at all times.

Over

Station 1, 2, 3, 4 or 5 **Menus In Monitor Mode**		
Function	Description	Active/Inactive
Run	Allows you to select a preset recipe from the Recipe File Directory to Run a gas analysis. *Run* data is automatically saved in the Data File Directory.	Active at all times, except when a Data File is Open, or a Recipe is already Running.
Stop	*Stops* a *Run.*; data automatically saved.	Active only during a *Run.*
New	Inactive in Monitor Mode.	Inactive in Monitor Mode.
Open	*Opens* the Data File Directory so that you can select a previously run analysis for Viewing, or Printing.	Active when no Data File is Open, or Recipe is Running.
Close	*Closes* the currently Open Data File. Note: Files must be Closed before proceeding to most other activities.	Active only when a Data File is Open or after a *Recipe* has been *Run.*
Arrange	Allows you to view or print graphs as *Quarter*, *Top Half*, *Bottom Half*, *Left Half*, *Right Half*, or *Full Screen.*	Active only when a Data File is Open, or Recipe is Running.
Axis	Allows you to change the Y axis on Analog or Static Scans or the X and Y axis in Dynamic Scans. Also, in Dynamic Scans, X axis functions allow *Zoom In* and *Zoom Out*. *Start Time* and *Page Width* adjustments.	Active only when a Data File is Open, or Recipe is Running.
Channels	Can choose Dynamic trace displayed.	Active post run only.
View	*View* a Graph or Table when not running a scan. During Dynamic scans, you can toggle between Bar and Time Profile Graphs, but Tables cannot be Viewed while Running.	Active only when a Data File is Open, or after a *Recipe* has been *Run. Bar-graph* is active only when Dynamic Scan is Running.
Recipes	Inactive in Monitor Mode.	Inactive in Monitor Mode.
Remote Status	Allows monitoring and control of the *Electron Multiplier* (voltage) *Filament* conditions, and *VSC* settings.	Active at all times.
Leak Hunt	Allows *Leak Hunting* on only one Station (at a time) with choice of gas. A Leakbar and Time Profile are shown.	Active at all times, except when a Data File is Open, or Recipe is Running.
Print	Provides the following print options: *Next* displays the next page of data to be printed. *Previous* displays the previous page of data to be printed. *Zoom* enlarges the data for pre-viewing; data can be positioned horizontally and vertically, with or without gridlines (use arrows). *Print* starts printing. Setup allows input of header, footer, row, and column headings. *Margins* frames the content. Select *Close* to end a printer formatting session.	Active only when a Data File is Open or after a Run.

QUALITORR REMOTE
HOST COMPUTER OPERATING INSTRUCTIONS
MONITOR MODE STEP-BY-STEP

Keyboard Operations

All Station functions in this document assume that Station 1 is used. Station 1 menus are selected by pressing Alt then 1, denoted by Alt, 1. The Station menus for Remote Stations 2, 3, 4, and 5 are accessed by selection of Alt, 2; Alt, 3; Alt, 4; and Alt, 5 respectively. The System Menu, common to all Stations, is selected by pressing Alt, S.

QualiTorr Remote Host function names all have letters that are underlined. An example is *Run*.. The combination Alt plus R is defined as the "Hot Key" for this function. To select a function from the menu, press Alt, 1 for the correct Station, plus R for *Run*, or any other function you desire. *OK* is activated by *Enter; Cancel* is activated by *Esc.*

If Dialog Boxes appear for any reason during operation, they should be Closed as soon as possible; the Host Computer cannot receive data while Dialog Boxes are Open.

If you have the optional Vacuum System Controller (VSC), and pneumatic valves, it is necessary to begin operation with all valves closed on the VSC front panel. This will put valve action in "sync" with the Host computer. Valve Status can be changed at the VSC, with the *Remote Status* function in each Station menu, or, from a Recipe.

To confirm that you are in *Monitor Mode,* or *Program Mode*, perform the following test at any time that all files are Closed: If the function *New* on the Station Menu is active (solid), you are in *Program Mode.* If the function *New* is inactive (gray), you are in *Monitor Mode.* Change of mode is executed from the System Menu.

Initialization

1. Before starting operation, all vacuum systems at each QualiTorr Remote Station must be *On* and pumped to operating vacuum levels. Note that when you turn the Station Controllers *On*, the filaments in each Station Probe will come *On.* **Lack of sufficient vacuum may result in filament damage.**

2. Turn *On* vacuum pumps, or Vacuum System Controllers (VSCs) if so equipped. (If using VSCs, *Pump Start* must be manually pressed. Wait for VSC System Ready.)

3. Turn *On* each of the Remote Station Controllers that will be used on the Network, (front panel breaker),waiting about 5 seconds between each one. Each Station Controller will perform a self-test procedure, this takes about one minute.

4. Turn *On* the Host Computer. The Host Computer will perform a self-test procedure. If the date is OK, press the *Enter* key. If the date is incorrect, enter the date in the format mm-dd-yy, and press *Enter.* If the time is OK, press *Enter.* If the time is incorrect, enter the time in the format HH-MM-SS.00x, where x is "a" for AM or "p" for PM. When the time is correct, press the *Enter* key.

5. When the Host computer self-test is complete, **the Remote Station(s) to be active on the Network must be selected** in the System Menu. **It is important to select only operational Stations for data taking.** Use Hot Keys. If Stations are changed, *Restart Net* must be used to accept them.

6. Note that if you select Alt, 1, the *Run, Open, Remote Status*, and *Leak Hunt* functions are active (solid), and *New* and other functions are inactive (gray), the System is now in *Monitor Mode.* This is the default mode.

7. Confirm that the Remote Controller is communicating with the Host Computer by selecting *Remote Status* of Station 1, (Press Alt, 1, m). Use Hot Keys to select *EM Voltage*, or, *Vacuum System Controller (*VSC). If the Remote Controller is communicating with the Host Computer, and the VSC, values will be displayed.

Over

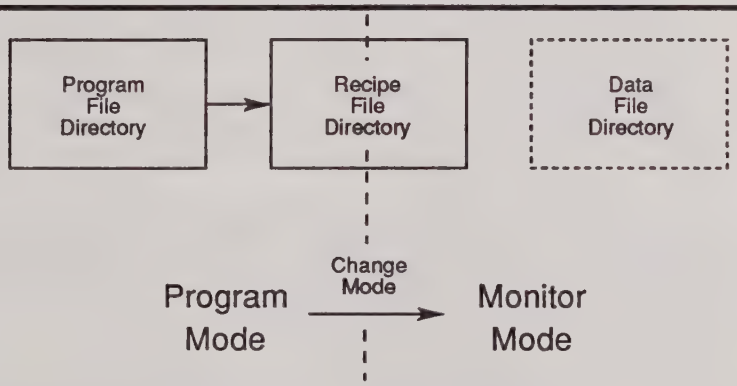
Monitor Mode Operation of Remote Station 1

Task	Procedure
To *Change Mode* from Monitor Mode to Program Mode	1. All files must be closed to Change Mode. 2. Press Alt, S to display the System Menu. 3. Press M to *Change Mode*.
To *Run* a Recipe listed in the Recipe File Directory	1. Press Alt, 1, R, to select *Run*. 2. Use the arrow keys to select a Recipe from the Recipe File Directory. **Only Recipes can be Run in Monitor Mode.** 3. Press the *Enter* key to *Run* the selected Recipe. This Recipe, with new data, is automatically Saved.
To *Stop* a Run	1. Press Alt, 1, S, to *Stop* (or abort) a Run .
To *Open* the Data File Directory	1. Press Alt, 1, O to *Open* the Data File Directory. 2. Use arrow keys to select a Data File **for Viewing or Printing.**
To *Close* a Data File	1. Press Alt, 1, C to *Close* the Open File. You must Close the File to move on to the next task.
To *Arrange* an Open or Running File	1. Press Alt 1, A to *Arrange* an Open or Running File. 2. Use Hot Keys to choose *Quarter Screen, Top Half Screen, Bottom Half Screen, Left Half Screen, Right Half Screen,* or *Full Screen.*
To change the *Axis* of an Open or Running File	1. Press Alt, 1, x to adjust the X or Y *Axis*. 2. Select the Y Axis Scale *Maximum* and/or *Minimum*. Use arrows to change values. 3. Select the X axis Scale by entering *Start* and *Width* values. 4. Select the *Start Time* (of display), and enter time in minutes. 5. Select the fixed display*Width*, and enter in minutes. 6. *Resume Collection Display* returns to normal display.
To change the *View* of an Open File when not running a Scan	1. Press Alt, 1, V to change the *View* between a Graph, or Table, when having completed a Static or Analog scan. *View* for a Dynamic Scan is slightly different, see below.
To change the *View* between a Bar Graph or Time Profile during a Dynamic Scan	1. Press Alt, 1, V to *View* a Bar Graph, or Time Profile Graph in Dynamic Scan. Note: Tables cannot be viewed during actual Run. After Run is completed,*View* will toggle between Time Profile and Table.
To confirm communication and to determine/change the status of the *Electron Multiplier, Eils.* and/or *VSC*.	1. Press Alt, 1, m to confirm *Remote Status*. Use Hot Keys to select *EM Voltage*, or *Vacuum System Controller (VSC)*. If the Remote Controller is communicating with the Host Computer, and/or the VSC, values will be displayed. 2. *Electron Multiplier Voltage, Filaments (On/Off)*, or *VSC* parameters can also be changed with the same Hot Keys.
To *Leak Hunt*	1. Select Alt, 1, L for *Leak Hunt;* use Hot Keys to select H for *Helium*, or A for Argon, etc. Press *Enter* to start run. A Leakbar and Time Profile will appear. Proceed with leak hunting. To abort *Leak Hunt* operation, press Alt, 1, Stop.
To *Print* an Open File	1. Press Alt, 1, P to select *Print* parameters. 2. Select *Next, Previous, Zoom, Print, Setup, Margins,* or *Close* with Hot Keys.

QUALITORR REMOTE
HOST COMPUTER OPERATING INSTRUCTIONS
PROGRAM MODE OVERVIEW

Program Mode functions under the *System* menu allow you to determine the QualiTorr Remote software version number, *Copy* Program Files, *Delete* Program Files, configure the QualiTorr Remote *Network, Change Mode* to Monitor Mode, and *Shutdown.*

Program Mode functions under the *Station 1, 2, 3, 4, or 5* menus are used to create *New* analyses for the Program File Directory; *Add* and *Delete* files from the Recipe File Directory by the use of the *Recipe* function; or, choosing *Open* allows you to select and Run analyses stored in the Program File Directory.You can also control the screen display and printing format of the data by the use of *Arrange, Axis,* Channel, and *View* functions. *Program Mode Run* results can be saved in the Program File Directory. All files are created in *Program Mode,* and stored in the Program File Directory. Recipes that are viewed in the Monitor Mode are selected from the Program File Directory and placed in the Recipe File Directory. These and other Program Mode functions are described below:



***System* Menu In Program Mode**

Function	Description	Active/Inactive
About QualiTorr Remote	Displays UTI's copyright notice, the version number of the QualiTorr Remote software, and UTI's address and telephone number.	Active at all times.
Copy Files	Copies Files from the Program File Directory to a floppy disk.	Active at all times.
Delete Files	Deletes files from the Program File Directory.	Active at all times.
Preferences	Allows naming Host and Station, choosing a password, and locking out inactive Stations.	Active at all times.
Network	Select which Remote Stations are to be active on the QualiTorr Remote Network.	Active at all times..
Change Mode	Initiates (toggles) a *Change* between *Program* and *Monitor Modes.*	Active at all times.
Shutdown	*Shutdown* terminates QualiTorr Remote communication with all Stations on the Network. *Shutdown* must be selected before turning the Host Computer and/or Station Controller Off.	Active at all times.

Over

Station 1, 2, 3, 4 or 5 Menus In Program Mode		
Function	Description	Active/Inactive
Run	Starts collection of New data, as directed by the chosen format. Will *Run* to completion or can be Stopped prematurely. Collected data can be optionally *Saved.*	Active when a Program File is Open, or a *New* File is created.
Stop	Terminates a *Run.* Collected data can be optionally *Saved.*	Active only during a *Run.*
New	Creates a *New* empty data file with chosen format and *Saves* it in the Program File Directory. Copy is stored on the hard disk. Selections of *Analog Scan, Dynamic Scan, Static Scan,* or *Calibration* can be chosen.	Active when no Program File is Open.
Open	*Open* the Program File Directory so that you can select a previously run analysis for Viewing, Printing, or Running again.	Active when no Program File is Open.
Close	*Closes* the currently Open Program File. Note: A File must be closed before it can be made into a Recipe or Copied (see Recipes below).	Active only when a Program File is Open.
Arrange	Allows you to view or print displayed Graphs as *Quarter, Top Half, Bottom Half, Left Half, Right Half* or *Full Screen.*	Active only when a Program File is Open, or Running.
Axis	Allows you to change the Y axis on displayed Analog or Static Scans or the X and Y axis on Dynamic Scans. Also, in Dynamic Scan, X axis functions allow *Start Time* and *Width* (display and Run duration) adjustments.	Active only when a Program File is Open, or Running.
Channels	Allows choice of Dynamic trace displayed.	Active post run only.
View	*View* a data file Graph or Table when not doing a scan. During Dynamic Scans, you can toggle between Bar and Time Pofile Graphs, but Tables cannot be Viewed while Running.	Active only when a Program File is Open.
Recipes	*Add* recipes from the Program File Directory to the Recipe File Directory, or *Remove* files from the Recipe File Directory.	Active when no Program File is Open.
Remote Status	Allows monitoring and control of the *Electron Multiplier* (voltage), *Filament* conditions, and *VSC* settings. Varifies Communication.	Active at all times.
Leak Hunt	Allows *Leak Hunting* on only one Station (at a time) with choice of gas. A Leakbar and Time Profile are shown.	Active when no other File is Open or Running.
Print	Provides the following print options: *Next* displays the next page of data to be printed. *Previous* displays the previous page of data to be printed. *Zoom* enlarges the data for previewing; data can be positioned horizontally and vertically with or without gridlines (use arrows). *Print* starts printing. *Setup* allows input of header, footer, row, and column headings. *Margins* frames the content. Select *Close* to end a printer formatting session.	Active only when a Program File is *Open* or after a *Run.*

QUALITORR REMOTE
HOST COMPUTER OPERATING INSTRUCTIONS
PROGRAM MODE STEP-BY-STEP

Keyboard Operations

All Station functions in this document assume that Station 1 is used. Station 1 menus are selected by pressing Alt then 1, denoted by Alt , 1. The Station menus for Remote Stations 2, 3, 4 and 5 are accessed by selection of Alt, 2; Alt, 3; Alt, 4; and Alt, 5 resepectively. The System Menu is selected by pressing Alt, S.

QualiTorr Remote Host function names each have a letter that is underlined when it is displayed on the screen. An example is *Run*. The combination Alt plus R is defined as the "Hot Key" for this function. To select a function from the menu, press Alt, 1 for the correct Station, plus R for *Run*, or any other function you desire. *OK* is activated by *Enter*; *Cancel* is activated by *Esc*.

If, for any reason, Dialog Boxes appear while the Host Computer is gathering data, they should be Closed as soon as possible; the Host Computer cannot receive data while Dialog Boxes are Open.

If you have the optional Vacuum System Controller (VSC), it is necessary to begin operation from the standby position with all valves closed on the VSC front panel. This will put valve action in "sync" with the Host Computer. (Valve Status can be changed at the VSC, or with the Remote Status function in each Station menu.)

Program Mode allows creation of new Data Files and/or Recipes, these can be Run (but not changed) in the *Monitor Mode*. Information must be intentionally Saved in *Program Mode*. The title bar tells you which mode you are in. Change of mode is executed from the System Menu.

Program Mode Operation of Remote Station 1

Task	Procedure
To *Open* a File listed in the Program File Directory	1. Press Alt, 1, O to *Open* the Program File Directory. 2. Use the arrow keys to select a Program File. 3. Press *OK (Enter)*.
To *Close* a Program File	1. Press Alt, 1, C to *Close* the Open File.
To *Run* an Open File or a New File	1. Press Alt, 1, R, to select *Run*. 2. When Run is complete, or prematurely stopped, a Dialog Box will appear. If *OK (Enter)* is pressed, New data is saved in place of old. If *Cancel (Esc)* is pressed, New data is lost, old data remains saved.
To *Stop* a Run	1. Press Alt, 1, S, to *Stop* a Run prematurely.
To *Arrange* an Open or Running File	1. Press Alt 1, A to *Arrange* an Open or Running File. 2. Use Hot Keys to choose *Quarter Screen, Top Half Screen, Bottom Half Screen, Left Half Screen, Right Half Screen,* or *Full Screen.*

Over

To create a *New* Program File	1. Press Alt, 1, N to create a *New* Program File. 2. Use Hot Keys to select an Analog Scan, Calibration, Dynamic Scan, or Static Scan. If valves are automated, proper valve action must be selected in each operation. 3. For an Analog Scan, enter the File Title, and mass numbers; Use tab keys. Press Enter when all settings are correct. 4. For a Dynamic Scan, enter the File Title and the duration of the scan (1-xxxx min.). Press Alt, A to assign *AMU* numbers and upper and lower alarm limits to each peak that will be monitored. Enter desired numbers. Use tab and *Hot Keys* to navigate. Press Enter when all settings are correct. 5. For a Static Scan, enter the File Title, use *tab* keys to highlight the AMU scan range, and type in desired numbers. Examples: 1-200 (this is the default setting); 2, 14-18, 28, 32, 36-40, etc. Press *Enter* when all settings are correct. 6. For a Calibration, use the Hot Keys. U selects the *UTI* Cal Gas for a complete calibration, A selects Argon for a partial calibration, or other choices are available. Tab to highlight the maximum pressure to be displayed on the screen. Enter the number (1.00e-2, etc.). Tab to highlight and enter the Calibration gauge pressure in the process chamber. Press Enter when all settings are correct.
To change the *Axis* of an Open or Running File	1. Press Alt, 1, x to adjust the X or Y *Axis*. 2. Select the *Y* Axis Scale *Maximum* and/or *Minimum*. Use arrows to change values. 3. Select the *X* axis Scale by entering Start and Width values. 4. Select the *Start Time* (of display), and enter time in minutes. 5. Select the fixed display *Width*, and enter in minutes. 6. *Resume Collection Display* returns to normal display.
Channels	1. Allows choice of Dynamic trace displayed.
To change the *View* of an Open File when not Running	1. Press Alt, 1, V, to change the *View* between a Graph, or Table, when having completed a Static or Analog scan. *View* for a Dynamic scan is slightly different, see below.
To change the *View* between Dynamic Bar Graph or Time Profile	1. Press Alt, 1, V, to *View* a Bar Graph, or Time Profile Graph in Dynamic Scan. Note: Tables cannot be viewed during actual Run. After Run is completed, *View* will toggle between Time Profile and Table.
To *Add* or *Remove Recipes*	1. Use Hot Keys. **To Add** from the Program File Directory to the Recipe File Directory: Alt, 1, *Recipe*; Alt *Add*, select File, *Enter*. **To Remove** from the Recipe File Directory: Alt, 1, *Recipe*, select Recipe, Alt *Remove*.
To confirm communication and to determine/change the status of the Electron Multiplier, Fils., and/or VSC.	1. Press Alt, 1, m to confirm *Remote Status*. Use Hot Keys to select *EM Voltage*, or *Vacuum System Controller (VSC)*. If the Remote Controller is communicating with the Host Computer, and/or the VSC, values will be displayed. 2. *Electron Multiplier Voltage, Filaments (On/Off)*, or *VSC* parameters can also be changed with the same Hot Keys.
To *Leak Hunt*	1. Select Alt, 1, L for *Leak Hunt*; use Hot Keys to select H for *Helium*, or A to select *Argon*, etc. Press *Enter* to open the File. Press Alt, 1, R to *Run Leak Hunt*. A Leakbar and Time Profile will appear. Proceed with leak hunting. To abort *Leak Hunt* operation press Alt, 1, Stop.
To *Print* an Open File	1. Press Alt, 1, P to select *Print* parameters. 2. Select *Next, Previous, Zoom, Print, Setup, Margins* , or *Close* with Hot Keys.

Appendix F

Vacuum System Controller

This appendix provides QualiTorr Remote Vacuum System Controller (VSC) installation and operating instructions.

Vacuum System Controller

(for Software 2.09 and later)

The Vacuum System Controller (VSC) provides control of the RGA system, power distribution for pump power, cooling fans, inlet and trap heaters, automatic valve switching, and control of the Atmospheric Pressure Sampling Modules (APSM).

General Operation

Audible Tones

Most functions of the VSC are operated by pressing the labelled buttons on the front panel (see diagram and table). Each time a button is pressed, there will be an audible tone. A short beep acknowledges the button has been pushed and indicates the selected function is being performed. A long beep acknowledges button has been pushed, but an error condition exists which prevents the function from being executed.

Normal Operation Sequence

The normal operation sequence of the VSC is:

1.) Turn on circuit breaker labelled POWER.
2.) Press SYSTEM POWER button. All indicator lights will light and tone will sound for approximately 2 seconds while the VSC performs a self-test. After the light and alarm test, VG-1 will display the version of software installed, VG-2 will display setting of S2 and INLET will display setting of S3. (see setting address for RS-485, page F-5)
3.) Adjust SET POINTS if required (see operation table).
4.) Press PUMPS START/STOP button. Pumps and valves will be automatically sequenced to pump system down.
5.) SYSTEM READY light will come on when SET POINT 2 on VG-1 and TURBO LED have been attained.
6.) Press BAKEOUT button to begin bakeout sequence. To bypass any bakeout step, press BAKEOUT button to advance to next step.
7.) Turn system off by pressing PUMPS START/STOP to shut off pumps, then turning POWER circuit breaker off. All valves will be closed and pumps and heaters shut down.

Changing VG-1 and VG-2 Set Points

Set points 1 and 2 on VG-1 and VG-2 are preset at the factory, and cannot be changed in normal operating mode. There are two ways to change these set points. To change them internally, remove the cover from the VSC and locate the DIP switch on the Main PC board labelled S3-8. The settings will be as shown in Figure A. Change the settings to those shown in Figure B. Then adjust the set points from the front panel in the same manner as the Inlet Gauge Set Points are adjusted (see operation table). When set points have been adjusted, return switch settings to those shown in Figure A and replace the top cover.

S3-8 in this position prevents making changes to VG1 and VG2 setpoints. (see Main Board diagram for location of S3.)

Switch S3

Figure A

S3-8 in this position allows changing VG1 and VG2 set points.

Switch S3

Figure B

Set points 1 and 2 can also be reset entirely from the front panel. Turn the VSC off and, while firmly pressing both the UP and DOWN buttons (D and E on Front Panel diagram) at the same time, turn the VSC back on. You will hear a series of short tones as the memory contents are set to zero. This will reset vacuum gauge constants and SET POINTS to zero. After resetting, any of the set points can be adjusted as shown in the operation table. It is recommended that after changing Set points 1 and 2 on VG-1 and VG-2 using the reset method that the VSC be turned off, then on normally (without pressing UP and DOWN buttons) to avoid resetting these set points inadvertantly in normal operation.

Changing EPROMS

The VSC is a software based control system which can be updated by changing the EPROM located on the Main PC Board. The EPROM is in a "zero-insertion-force" socket on the right side of the PC board. NOTE THE ORIENTATION OF THE EPROM. To change the EPROM, raise the lever on the socket and lift out the EPROM (note the orientation of the notch). Place the new EPROM in the socket with the notch in the same orientation, being careful to get all pins inserted in the socket. Push the lever down to lock it in place.

Resetting Constants and Set Points (Software 2.09 and later)

If the Convectron readings seem wrong or do not respond to the ZERO and ATM buttons, it could be that the values stored in non-volatile memory have become faulty. To reset these to zero, turn off the VSC. Firmly press both the UP and DOWN buttons (D and E on Front Panel diagram) at the same time. Turn the VSC on. You will hear a series of short beeps as the memory contents are set to zero. This will set vacuum gauge constants and SET POINTS to zero.

Reading Software Version, S2 and S3 Settings

When the VSC is turned on, all front panel LED's will turn on for a few seconds. Immediately following this, VG-1 will display a value, e.g. 210 mtorr. This indicates software version 2.10 is installed.

Similarly, the switch values of S2 and S3 are displayed on VG-2 and INLET, respectively. This information will be useful when discussing technical questions with the factory. See page F-8 for further information on APSM operation.

Setting address for RS-485 I/O

Switch S3

Value is read as zero.

Value is read as follows:

S3-1	:	1	RS-485 address
S3-2	:	2	
S3-3	:	4	
S3-4	:	8	
S3-5	:	16	Not used
S3-6	:	32	
S3-7	:	64	
S3-8	:	128	Set point control (see above)

Figure C

To interpret the value of S3, convert the displayed value to its hexidecimal equivalent. For example, following the LED test, INLET pressure indicates 143 mtorr.

143 (decimal) = 8F (hexidecimal)

The second digit indicates the address of the controller for the RS-485. In this case the address is F, or 15 in decimal. The range of addresses for the RS-485 is 0 through F, hexidecimal (0-15, decimal). S3-1 through S3-4 may be changed to set the address to a new value (see Figure C).

The first digit indicates the setting for set point control (see Changing VG-1 and VG-2 Set Points, preceding). This digit typically will be 0 or 8. If the value is 8 or higher, i.e 8, 9, A, B, C,D,E or F, the set point control is set to prevent changing VG-1 and VG-2. If it is less than 8, VG-1 and VG-2 may be set from the front panel.

S3-8 (bit 8, hex 80) is used for set point control. Currently bits 5,6,7 (hex 10,20,40) are not used. Future options may use these settings.

Vacuum Gauge 2 will display the value of switch S2 following the power-on LED test. To interpret the value of S2, convert the displayed value to its binary equivalent. For example, following the LED test, VG-2 indicates 080 mtorr.

080 (decimal) = 01010000 (binary)

Ignore the right four zeros, they will always be zero. The leftmost digit is for APSM 4, the next for APSM 3, etc. A "1" indicates APSM mode has been selected; a "0" indicates normal operation has been selected. In this example APSM has been selected for APSM/AUX 1 and APSM/AUX 3; normal operation has been selected for V2 and V4.

Table F-1. Troubleshooting

Symptom	Remedy
System turns on, but pumps (rough, interstage and turbo) don't come on; also, AC outlets are dead.	Check to see if the ground fault interrupter is properly set. The red button must be depressed (see q on pages F-12 and F-14).
Vacuum gauge(s) read strange values; e.g., system is at high vacuum, but vacuum gauge reads high pressure.	The internal calibration factors for the vacuum gauges may have become corrupted by a transient. See page F-4, Resetting Constants, to reset these.
System resets itself when some valves are activated.	Check to see that snubber diodes in valve cabling are correctly polarized; see page F-16.

Vacuum System Controller Specifications

Valve Control

8 valves, 24 VDC, 0.25 amp max.
8 switch closure detect
2 valves, 24 VDC, 0.25 amp for FORELINE and INTERSTAGE

Filament Off

+5 VDC CMOS output

Alarm Output

+5 VDC CMOS output

Vacuum Gauge

Input for three Granville-Phillips Convectrons

Serial I/O

RS-232 (2400 baud, 8 bits, NP, 1SB) and RS-485 (300-9600 baud)

Vacuum Loss

+ 5 to + 24 VDC input, selectable polarity
(i.e. +5 VDC = vacuum loss or 0 VDC = vacuum loss)

External Emergency Off

User selectable (internal shunt) to permit External Emergency Off

Turbopump

Supplies line voltage to fan and heater (switched) and 40 VDC to purge valve.
Interfaces to Balzers TCP 120 turbo controller.

Heaters

Supplies line voltage, 2 amp max, to AUXILIARY, TRAP 1, TRAP 2, INLET, PROBE; heater sequence is internally controlled to cycle heating and cooling.

Line Voltage Output

All are Ground Fault Interrupt protected; Switched outputs for ROUGH PUMP and INTERSTAGE PUMP, 8 amp max running; six unswitched convenience outlets.

Front Panel Controls

EMERGENCY OFF
SET POINT ADJUST
EIGHT VALVE / APSM/ AUX
INLET HEATER
PUMPS START/ STOP
SET POINT RAISE
ALARM OFF
PUMP HEATER
START BAKEOUT
POWER ON/ OFF (circuit breaker)
SYSTEM POWER(pushbutton)
SET POINT LOWER
PROBE HEATER
AUXILIARY HEATER
VAC/ ATM for three vacuum gauges

Front Panel Indicators

Each vacuum gauge is three 14mm red LED seven segment display.
torr/mtorr are LED backlit indicators. Other indicators are red LED.
Audible annunciator for alarm or button "chirp".

Size

Standard EIA 5 1/4" x 19" rack panel by 17" deep

Weight

24 lbs.

Power Requirements

110 VAC 50/60 hz, 20 amp, standard three wire US plug

This mode of operation is for use when pressure from the chamber to be sampled is lower than 10 torr. For use in sampling applications at higher pressures, APSM hardware must be installed, and APSM mode used.

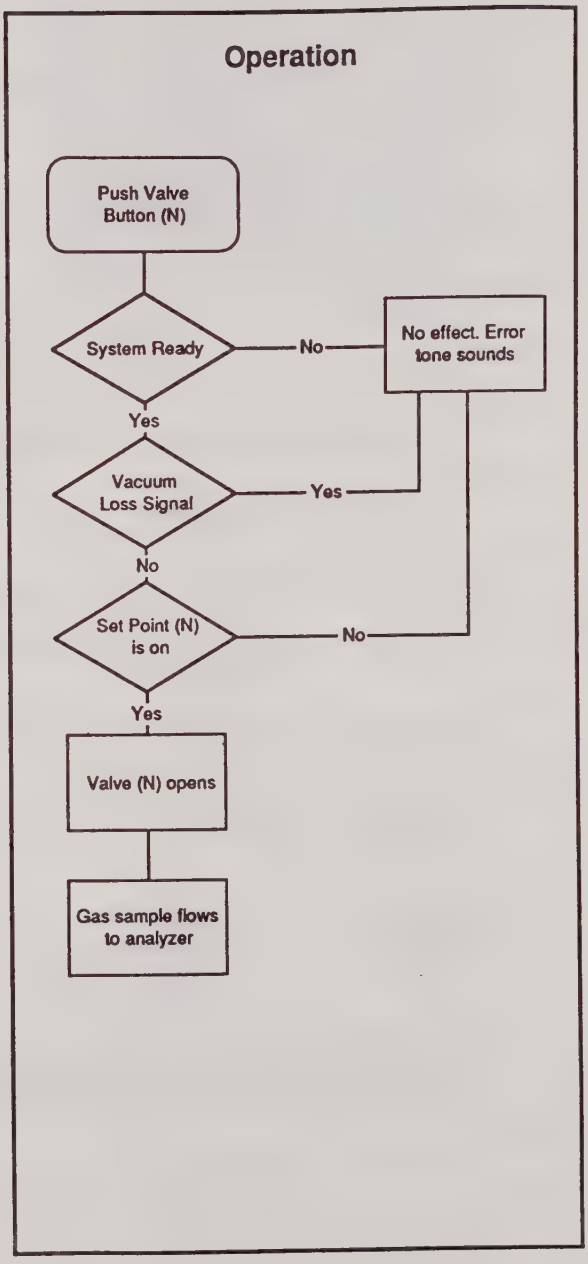


Figure F-1. Normal Operation, Valve 1 to Valve 4

APSM mode is used when the gas to be analyzed is over 10 torr in pressure. The sampling process is accomplished with an intermediate step to reduce the pressure of the gas sample to a level tolerated by the analyzer.

Enabling APSM

Open cover of VSC. Find DIP switch labelled S2 near front right corner of main PC board. Set switch as shown in diagram.

DIP Switch S2

Position 1 - 4	No function
Position 5	APSM 1
Position 6	APSM 2
Position 7	APSM 3
Position 8	APSM 4

In UP ↑ Position, normal operation.

In Down ↓ Position, APSM functions.

(See Main Board diagram for location of S2)

About APSM Operation

When in $APSM_n$ Mode, pressing $Valve_n$ always gives long beep (error signal). Valve Override may be used to activate V1 - V4 and AUX1 - AUX 4, regardless of pressure and set point.

If in APSM mode, and conditions are not met, a long beep (error signal) will sound when APSM is pressed.

When not in APSM mode (Normal Operation), APSM/AUX buttons send power to corresponding connector, regardless of pressure or other conditions.

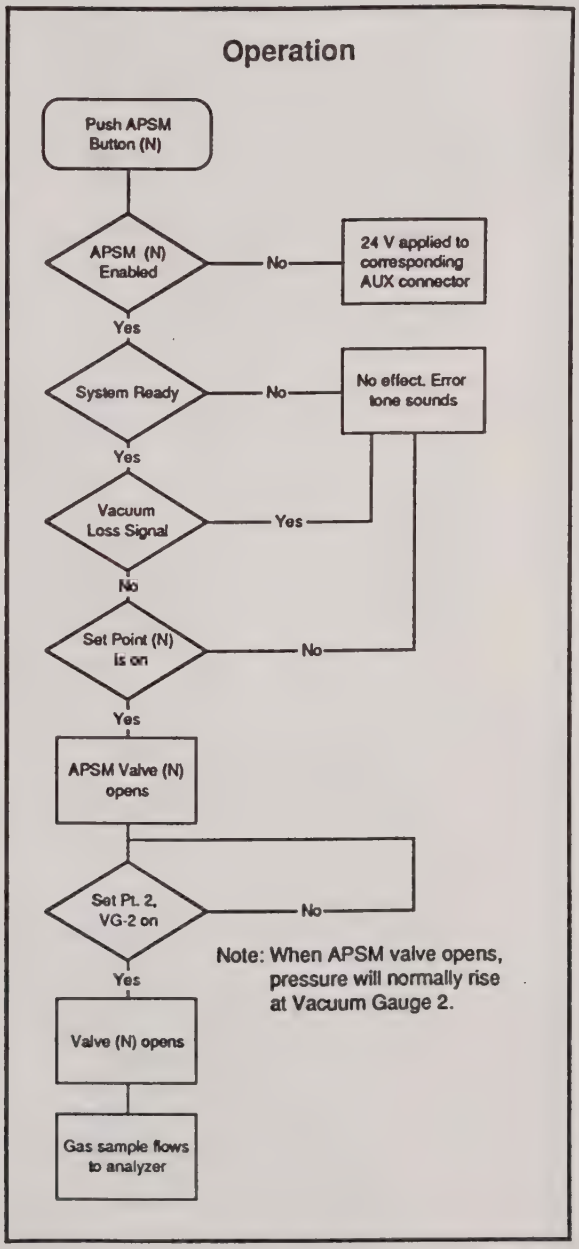


Figure F-2. APSM (Atmospheric Pressure Sampling Module)

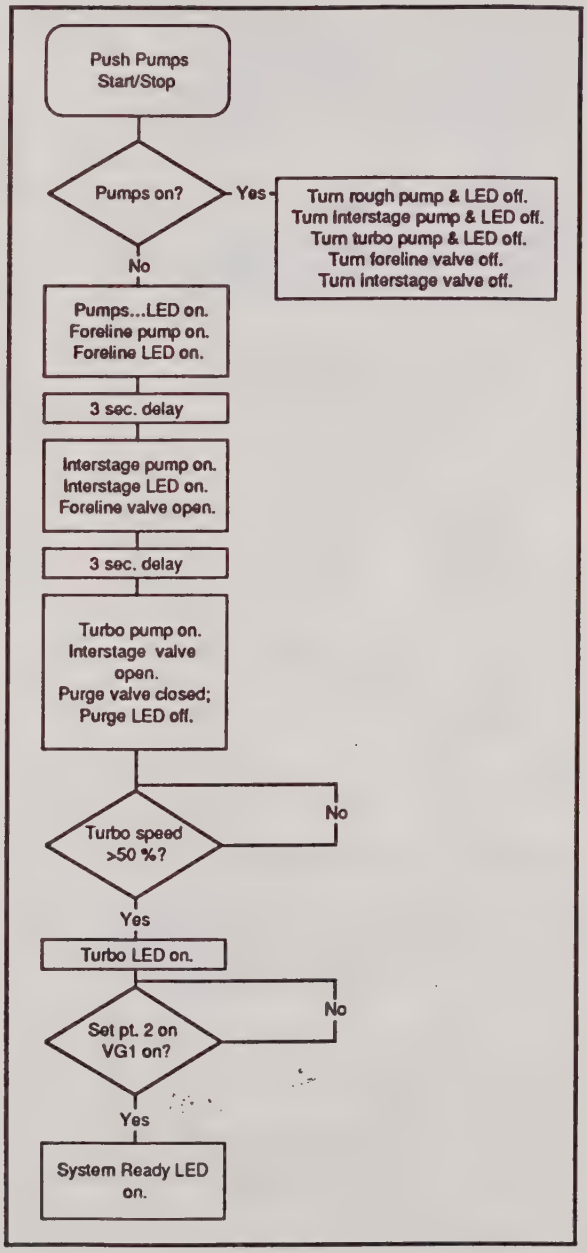


Figure F-3. Pump Sequence

NOTE: During the delay periods, the START BAKEOUT button may be pushed to advance to the next step in the sequence.

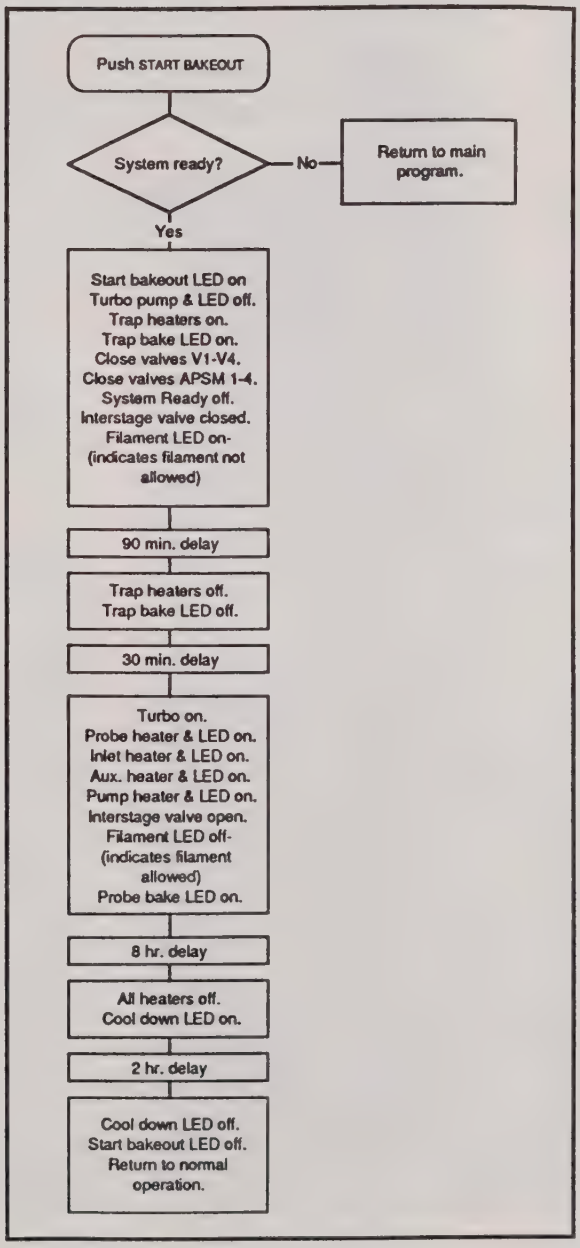


Figure F-4. Bakeout Sequence

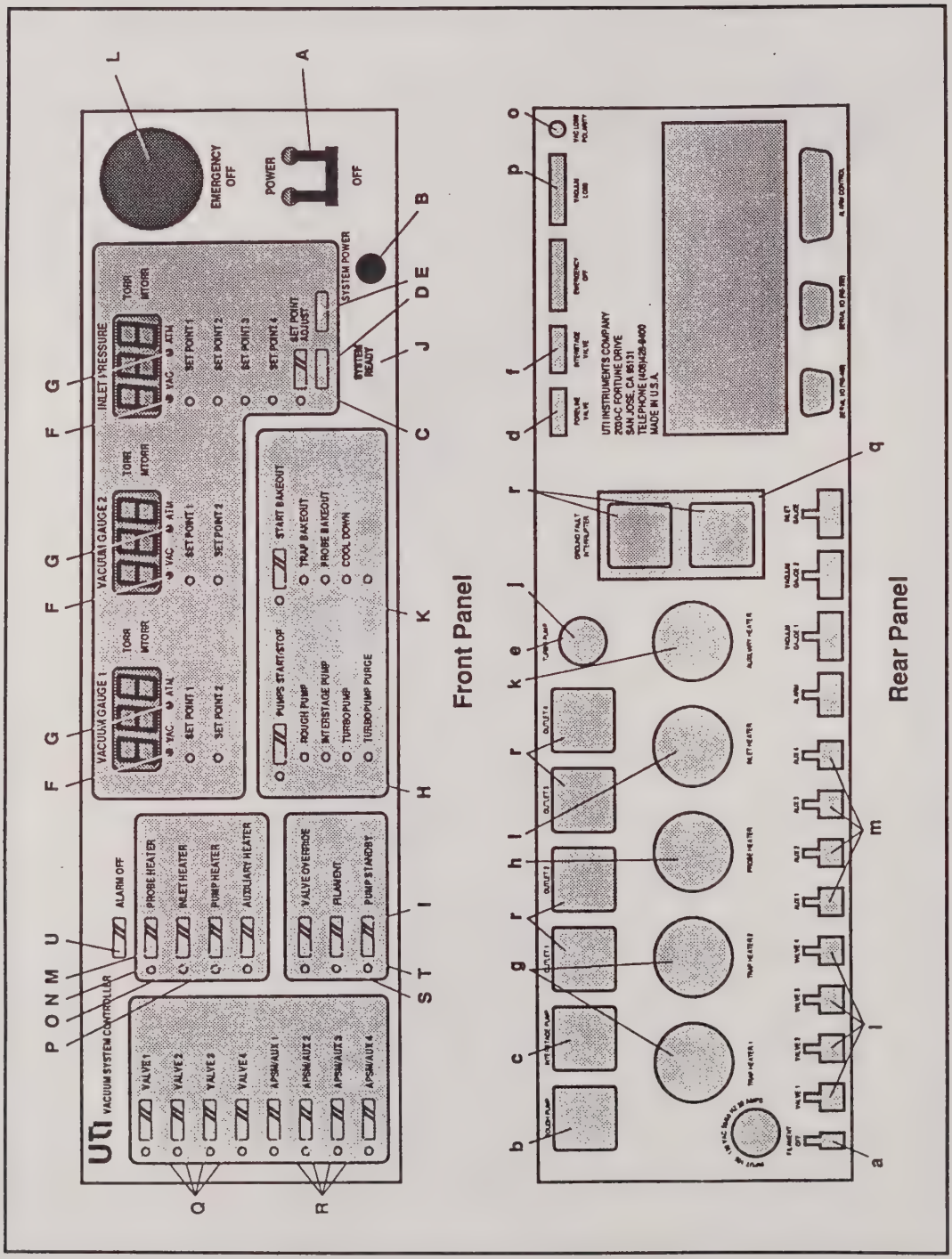


Figure F-5. Front and Rear Panels

Key*	Button	Effect on Controller	Effect on System
A	POWER (Breaker)	Activates Vacuum System Controller 24V supply	none
B a	SYSTEM POWER	Performs self-test of VSC (all indicators are lit) for a few seconds. Applies 5V to Filament Off connector (a) on back panel. Filament Off indicator on front panel is lit. Turbo Purge indicator is lit. Vacuum gauge pressures and inlet pressure displayed. Set point indicators will be lit if pressures are below set point.	none Turns Filament off. Purge valve is open. Reads vacuum gauge pressures and inlet gauge pressure. Set Point 1 on VG-1 is typically 25 mtorr. Set Point 2 (typ. 100 mtorr) on VG-1 must be reached for System Ready Set Point 1 on VG-2 is typically 900 mtorr. Set Point 2 on VG-2 is typically 1.00 torr. Set Point 1 on Inlet Pressure must be reached to open Valve 1. Set Point 2 on Inlet Pressure must be reached to open Valve 2. Set Point 3 on Inlet Pressure must be reached to open Valve 3. Set Point 4 on Inlet Pressure must be reached to open Valve 4.
C	SET POINT ADJUST	Set points for VG-1 and VG-2 are preset at the factory. These can only be changed by unlocking internal DIP switch (see "Changing VG Set Points") Four Inlet Pressure set points can be programmed on the front panel with the Set Point Adjust. Pressing this button will cycle through the 8 set points (current set point's indicator lamp will be flashing) and back to normal operation. The currently selected set point's level will be shown on display.	
D E	SET POINT UP SET POINT DOWN	This changes the currently selected set point up or down. Indicator light of set point being adjusted will be flashing. Single push of button adjusts set point 1 mTorr below 10 Torr, 100 mTorr above 10 Torr. Holding button down changes set point at an accelerating rate. The set points for VG-1 and VG-2 are displayed, but cannot be adjusted without unlocking internal DIP switch (see "Changing VG Set Points"). NOTE: The increment of change varies according to the vacuum level due to rounding in the operating program. ALL GAUGE DISPLAYS ARE DISABLED AND ALL FUNCTIONS ARE SUSPENDED WHEN IN SET POINT ADJUSTMENT ROUTINE. DO NOT LEAVE VSC IN SET POINT ADJUST MODE.	
F	VAC	Sets display to zero when system pressure is < 40 mTorr. (No effect if display reading is ≥ 40 mTorr.)	Use to "zero" gauge display when system pressure is known to be < 1 mTorr
G	ATM	Hold in and use the SET POINT UP & DOWN buttons to adjust display to local atmospheric pressure. (No effect if display reading is < 300 Torr.)	Use to calibrate gauge display to local pressure when system is at atmosphere.
H b,c,d, e,f	PUMPS START/STOP	Applies line voltage to Rough Pump connector (b) on rear panel. Rough Pump indicator lamp lights. TURBOPUMP PURGE indicator lamp turns off. After 2 second delay, applies line voltage to Interstage Pump connector (c) on rear panel. Applies 24V to Foreline Valve connector (d) on rear panel. Interstage Pump indicator lamp lights. After additional 2 second delay, applies power to Turbopump connector (e) on rear panel. Applies 24V to Interstage Valve connector (f) on rear panel. Turbopump Purge indicator lamp goes out. When turbopump reaches 50% of final speed, Turbopump Indicator lamp lights. (Depending on system pressure, this could be immediately up to several minutes.) When pumps are running, removes power from all connectors.	Starts Rough Pump. Starts interstage pump. Opens roughing valve. Applies power to turbopump. Opens interstage valve. Closes turbo purge valve.[1] Turns off pumps and shuts valves.

I	PUMP STANDBY	Signals turbopump controller to go to standby mode.	Signals Turbopump Controller to reduce pump speed to idle mode (66% of rated speed).
J	SYSTEM READY	Lights when TURBOPUMP indicator light is on and Set Point 2 on VG-1 is attained.	Can operate valves and execute bakeout.
K g,h	START BAKEOUT	SYSTEM READY light must be on to operate. Turns Start Bakeout indicator light on. Applies line voltage to Trap Heater connector (g) on rear panel. Turns off System Ready indicator. Turns Filament Off indicator on.[2] After 2 hours, Trap Bakeout light goes off, power to Trap Heater connector is turned off. Applies line voltage to Probe, Inlet, Pump and Auxiliary Heater connectors (h) on rear panel. PROBE BAKEOUT indicator turns on. After 8 hours, Probe Bakeout light goes off, power to Probe Heater connector is turned off. COOL DOWN indicator turns on.[3]	Suspends all other system functions. Turns off filament. Turns on Trap Heaters. Trap Bakeout lasts for 90 minutes followed by 30 minute cool-down on automatic cycle, or until advanced by pressing the Start Bakeout button. Turns off Trap Heaters. Turns on Probe Heaters. Probe Bakeout lasts 8 hours on automatic cycle, or until advanced by pressing Start Bakeout button. Turns off Probe Heaters. Cool Down cycle lasts for 2 hours on automatic cycle, or until advanced with the Start Bakeout button.
L	EMERGENCY OFF	Turns off power to VSC and to all rear panel connectors.	Shuts down all pumps. Shuts all valves. Turns off all heaters.
M h	PROBE HEATER	Applies line voltage to Probe Heater connector(h). Lights PROBE HEATER indicator. Will not operate unless System Ready light is on. Turns off if on.	Turns on Probe Heater if System Ready conditions are met.
N i	INLET HEATER	Applies line voltage to Inlet Heater connector(i). Lights INLET HEATER indicator. Will not operate unless System Ready light is on. Turns off if on.	Turns on Inlet Heater if System Ready conditions are met.
O e,j	PUMP HEATER	Applies line voltage to Pump Heater line (j) in Turbo Pump connector (e). Lights PUMP HEATER indicator. Will not operate unless System Ready light is on. Turns off if on.	Turns on Pump Heater if System Ready conditions are met.
P k	AUXILIARY HEATER	Applies line voltage to Auxiliary Heater connector(k). Lights Auxiliary Heater indicator. Will not operate unless System Ready light is on. Turns off if on.	Turns on Auxiliary Heater if System Ready conditions are met.
Q l	VALVES 1-4	If corresponding INLET PRESSURE Set Point indicator is on and System Ready light is on, applies 24V to corresponding connector (l) on rear panel. If valve is open, turns off 24V. If VACUUM LOSS signal is present, valves will not open; see o,p below.	Opens valve if system pressure is below Inlet Pressure Set Point corresponding to valve. If valve does not send opening signal in 1.5 seconds, a warning signal consisting of a short and a long tone will sound. Sends signal to close valve. If valve does not send closure signal in 1.5 seconds, a warning signal consisting of a short and a long tone will sound.
R,m	AUX 1-4	24V applied to corresponding connector (m) on rear panel. Indicator is lit.[4]	
S	VALVE OVERRIDE	Allows Valves to be operated when SYSTEM READY and Set Point conditions are not met.	
T n	FILAMENT OFF	When indicator is lit, 5V applied to Filament Off connector (n) on rear panel	Indicator light is out when System Ready is on or in Probe Bakeout or Cool Down cycle and Set Point 2 of VG-1 is reached. Can always change state if System Ready light is on. Either turns filament off, or prevents it from being turned on.
U	ALARM OFF	Turns off audible alarm for current alarm condition (warning light continues to flash until alarm condition is corrected). Does not turn off for other alarms.	
o,p	VACUUM LOSS POLARITY (rear panel)	If in plus position, interprets + voltage on Vacuum Loss connector (p) to indicate vacuum loss (voltage range +5V to +24V). If in minus position, interprets 0V to indicate vacuum loss.	If vacuum loss indicated, prevents valves from opening .
q	GROUND FAULT INTERRUPTER	Disconnects line voltage if current is detected in ground line of line voltage.	If AC outlets, pumps and turbo pump are inactive, check to see if red reset button on Ground Fault Interrupter is depressed.
r	AC outlets	Unswitched AC outlets at line voltage.	Max. load 5 amps per outlet, 20 amps total of all outlets.

* Capital key letters are items on front panel. Lower case key letters are items on rear panel.

[1] Under high vacuum conditions, Turbo Purge Indicator may remain off for > 1 hour after Turbo Pump is shut off. Valve is kept closed by a turbo until pressure rises to acceptable level.

[2] Trap bakeout is frequently bypassed in routine bakeout procedures by pressing START BAKEOUT button, a second time.

[3] After 2 hours, Cool Down indicator turns off.

[4] See APSM description for effect of these buttons in APSM mode.

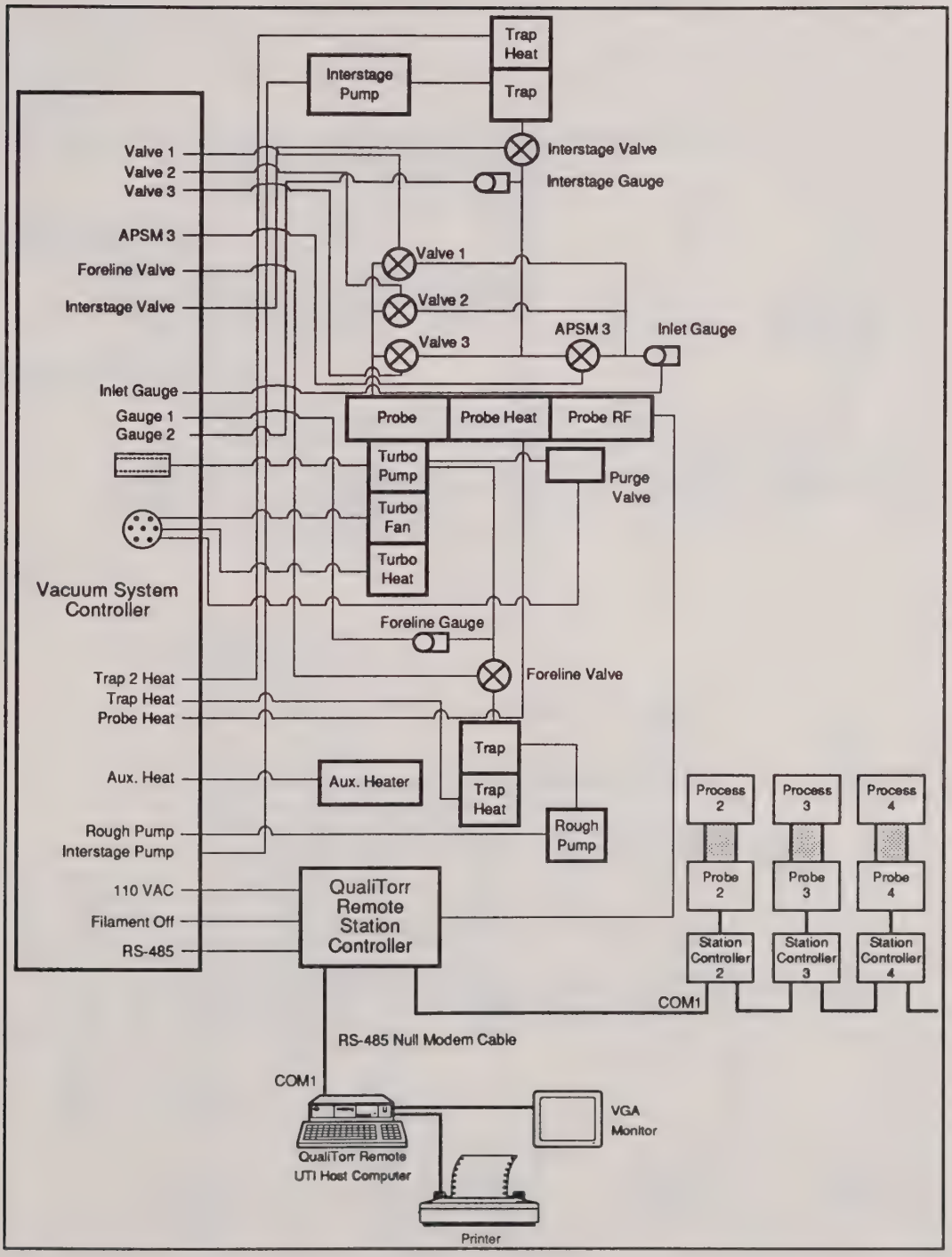


Figure F-6. QualiTorr Remote with Vacuum System Controller

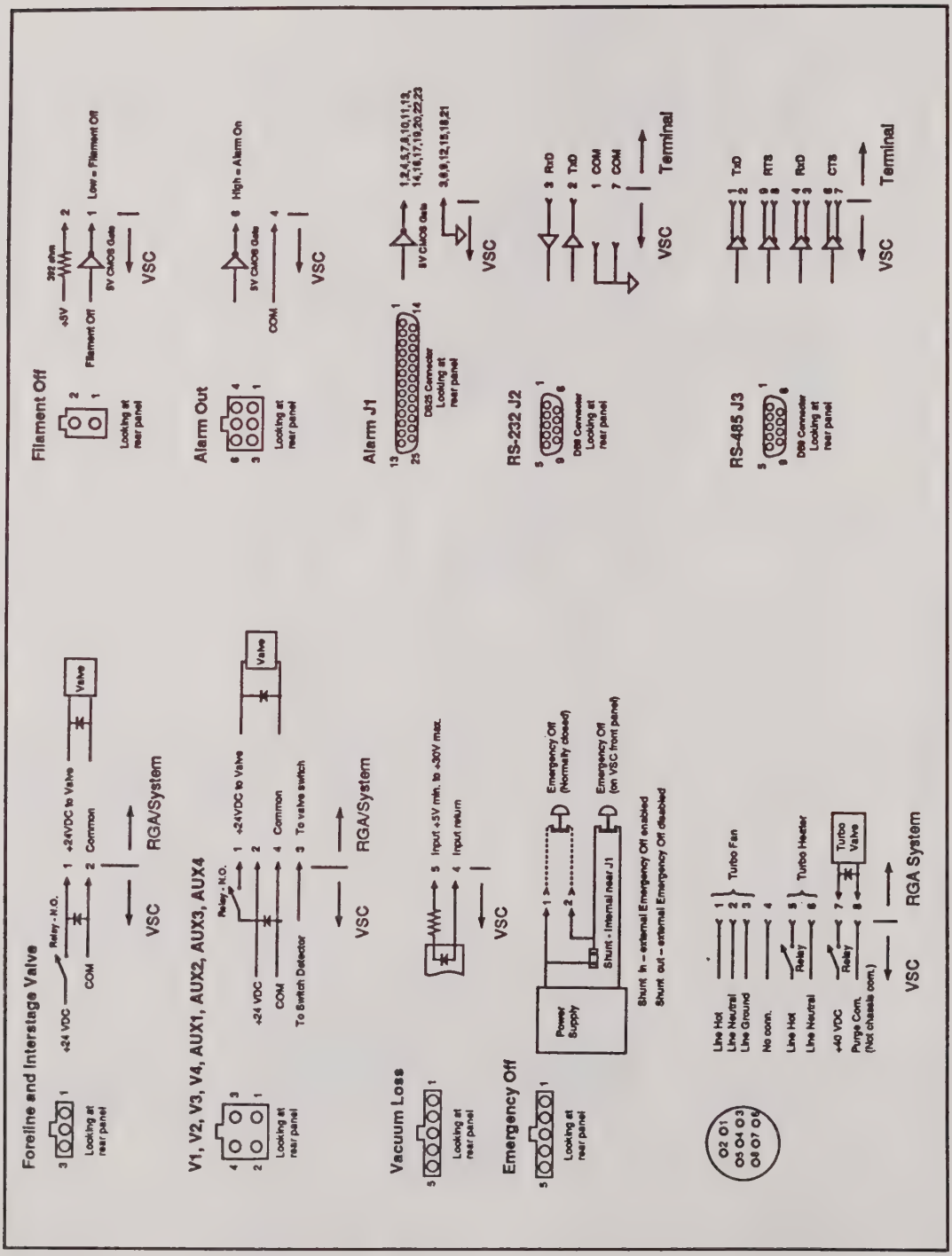


Figure F-7. Rear Panel Connector Diagrams

Set Points

Forelines

VG 1 (Turbo Foreline) and VG 2 (Interstage Foreline) Set Points are factory set.*

a. VG 1:SP 1 = 25 mTorr, SP 2 = 100 mTorr
b. VG 2:SP 1 = 900 mTorr. SP 2 = 1 Torr

Inlet Pressures

a. Valve V 1 = SP 1 = 10 mTorr
b. Valve V 2 = SP 2 = (your choice)
c. Valve V 3 = SP 3 etc.

Changing the Set Points

a. INLET Set points are adjusted from the front panel.
b. FORELINE Set Points (VG 1 & VG 2), originally factory set*, **can** be changed by:
    1. Turn ON system Power with Raise and Lower buttons pressed
    2. Adjust as desired
    3. Turn OFF power, then back ON

Bakeout

1. Press START BAKEOUT
    a. Trap Heater comes ON
    b. Filaments OFF
    c. System Ready goes OFF ....traps bake for 2 hours.

2. After 2 hours....
    a. Trap Bakeout light goes out, Trap Heater power goes OFF
    b. Power goes ON to Probe Inlet heaters
    c. Power goes ON to Turbo Pump and Auxiliary Heaters
    c. Probe Bakeout light comes ON ....bakeout proceeds for 8 hours.

3. After 8 hours....
    a. Probe Bakeout light goes OFF
    b. Other heater power is OFF
    c. Cool Down indicator comes ON
    System will cool for 2 hours automatically, or, can be advanced with Start Bakeout button.

* Typical for Turbo-foreline systems

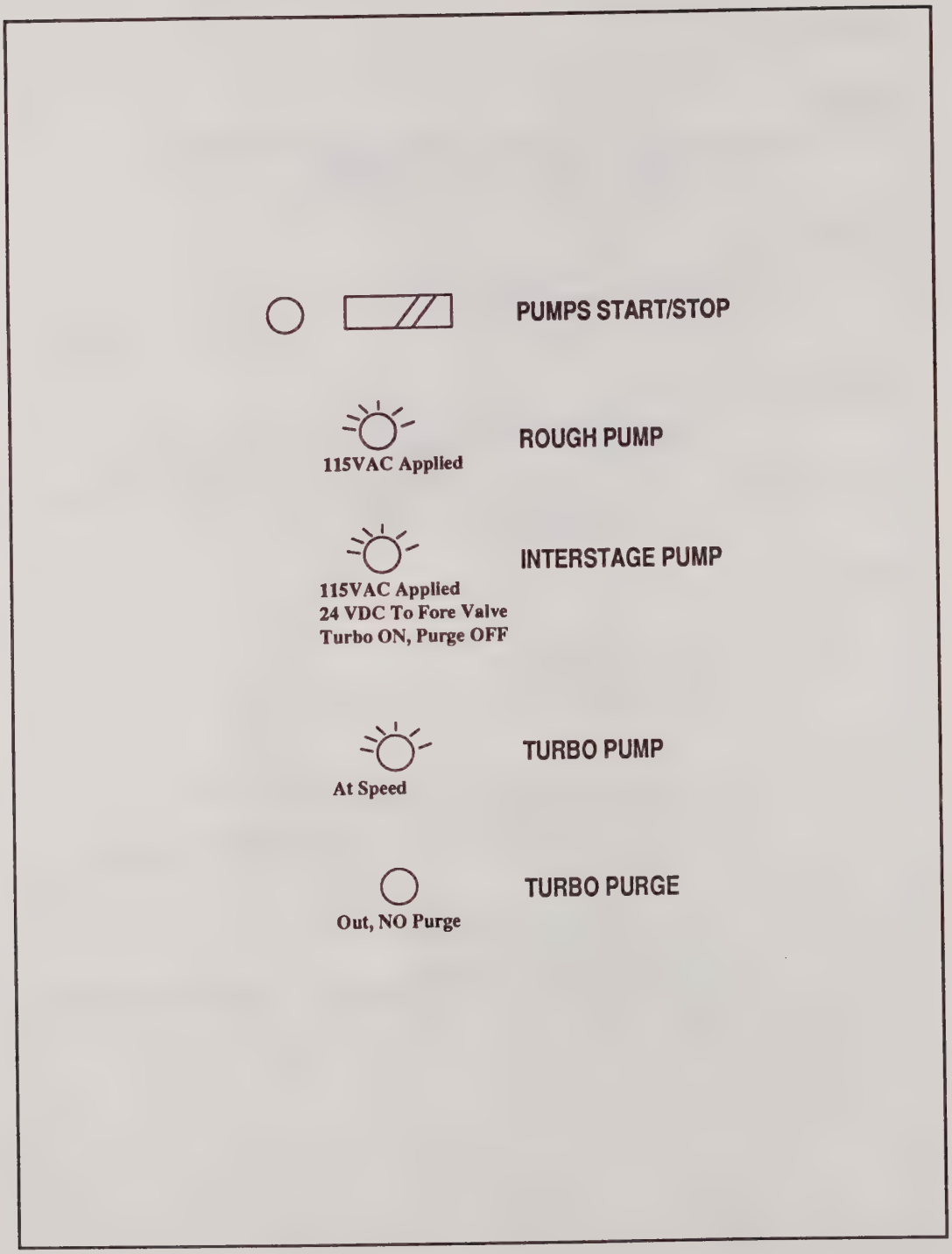


Figure F-8. Vacuum System Controller Symbols

Set Points

Forelines

VGA 1 (Turbo Foreline) and VG 2 (Interstage Foreline) Set Points are factory set. *

a. VG 1: SP 1 = 25 mTorr. SP 2 = 100 mTorr
b. VG 2: SP 1 = 900 mTorr. SP 2 = 1 Torr

Inlet Pressures

a. Valve V 1 = SP 1 = 10 mTorr
b. Valve V 2 = SP 2 = (your choice)
c. Valve V 3 = SP 3 etc.

Changing the Set Points

a. Inlet Set Points are adjusted from the front panel.
b. FORELINE Set Points (VG 1 & VG 2), originally factory set*, **can** be changed by:
    1. Turn ON system Power with Raise and Lower buttons pressed
    2. Adjust as desired
    3. Turn OFF power, then back ON

Bakeout

1. Press START BAKEOUT
    a. Trap Heater comes ON
    b. Filaments OFF
    c. System Ready goes OFF.
    d. Interstage Valve and all Sample Valves are Closed.
    e. Purge Valve on Turbo Opens (through VCR orifice) ....Traps bake for 90 minutes.
    f. Trap Heater is turned OFF (LED OFF) ....Thirty-minute delay.

2. After thirty-minute delay....
    a. Turbo comes ON (LED ON).
    b. Trap Bakeout LED goes out, trap heater power goes OFF
    c. Power goes ON to Probe Inlet heaters
    d. Power goes ON to Turbo Pump Heater and Auxiliary Heaters.
    e. Filament LED OFF (allows Filaments ON).
    f. Probe Bakeout LED comes ON ....bakeout proceeds for 8 hours.

3. After 8 hours....
    a. Probe Bakeout light goes OFF
    b. Other heater power is OFF
    c. Cool Down indicator comes ON
    System will cool for 2 hours automatically, or, can be advanced with Start Bakeout button.
    d. Return to normal operation.

* Typical for Turbo-foreline systems

Appendix G

Glossary

Absolute Pressure: A pressure measurement that is made relative to a standard pressure, such as the pressure required to support a column of 760 mm of mercury (Hg). All absolute pressures are traceable to measurements made by a standardization laboratory, such as the National Bureau of Standards in the United States. The international unit of absolute pressure is the Pascal. Other absolute pressure units include Atmosphere (Atm), Torr, Bar, and Micron. Compare **Relative Pressure** and **Partial Pressure.**

Alphanumeric: A character set that contains both the letters in the alphabet and numbers.

AMU: Abbreviation for *Atomic Mass Unit.*. By international agreement, the most abundant isotope of carbon, ^{12}C, is the reference element for the atomic mass scale currently in use and 12 is its accepted atomic mass. Therefore, one AMU is defined as exactly equal to 1/12 of the mass of a ^{12}C atom. The AMU for other elements are calculated from their respective atomic masses. The AMU for molecules is calculated from the sum of the component elements. One AMU is called one *dalton*.

Analog Scan: This type of scan is primarily used for checking peak quality characteristics of the Process Monitor itself. The Analog Scan can be used for any existing peak and is selected with a field width to show peaks adjacent to the principle AMU of interest. See also **Programmable Scan**.

Atmosphere: A unit of pressure equal to the pressure required to support a column of mercury that is 760 mm high. One standard atmosphere equals 760 Torr, 1.01×10^3 Millibar, and 1.01×10^5 Pascal.

Auto Run Mode: See **Run Mode**.

Auto-Compare Mode: See **Run-Compare Mode**.

BAG: Abbreviation for a *Bayard-Alpert Gauge*. See **Bayard-Alpert Gauge**.

Bakeout: A process consisting of heating the vacuum system while the vacuum pumps are running to decrease the amount of contamination inside of the system. Baking the vacuum system increases the temperature and vapor pressure of the contaminants to increase their rate of desorption from the internal vacuum system surfaces. Baking vaporizes the contaminants from the walls of the vacuum components so that they can be swept through the turbomolecular and mechanical pumps and out of the system using a flushing gas. When the temperature is reduced at the end of the system bakeout, the amount of contamination and its corresponding vapor pressure will be significantly reduced. This is easily confirmed by evaluating QualiTorr Remote spectra from before and after a system bakeout.

Bar Graph: A Control Console data display format that uses the height of a bar to indicate the parameter value. With the QualiTorr Remote, the Static Scan function displays bar graph information. When using the Dynamic Scan function, the Graph button switches the display between a bar graph and a time profile plot.

Bar: A unit of pressure equal to 0.987 Atmosphere, 750 Torr, 10^5 Pascal, and 7.5×10^5 Microns. One thousand millibars (mBar) are equal to one Bar.

Bayard-Alpert Gauge (BAG) : A type of pressure gauge. This gauge is used during *calibration* so that the partial pressures measured by the QualiTorr Remote are displayed in proper relative units The response of this type of ion gauge is usually referenced to nitrogen. A capacitive manometer provides true pressure values.

Boot: The initial loading of information into a computer. A boot or a booting of the QualiTorr Remote requires that the internal disk and that a properly initialized external disk are installed. The keyswitch is then turned clockwise *beyond* the Program position for momentary contact.

Calibrate: This function provides an automatic calibration to a known gas mixture at a known pressure. The calibration consists of the determination of AMU location and specific gas sensitivity coefficients.

Calibration Gas: A gas that is used during calibration and adjustment of the QualiTorr Remote to provide a sample of known composition. The UTI Calibration Gas is a quantitatively analyzed mixture of nitrogen, hydrogen, helium, argon, krypton, and xenon.

Calibration Table: The nominal sensitivity factors for each calibration gas component are adjusted during the Calibration Procedure to produce compositional readouts identical to that certified by the calibration gas supplier. Proportional adjustments in the sensitivity coefficients at the other locations in the 1 to 200 AMU range are then determined. These results are saved in the Gas Calibration Table on the System Disk.

Computer Interface: An electronic circuit that ensures that data protocols are properly matched between the computer and the gas analyzer.

Conflat Flange: A type of metal vacuum connection. Conflat is a registered trademark of Varian Associates, Palo Alto, CA, USA. The Conflat flange seal is based on a gasket capturing design. As the seal is made, the knife-edges bite into the copper gasket causing the gasket to flow outward until it encounters the gasket supporting surfaces, where further movement is no longer possible. As the flange faces come together, a tremendous mechanical pressure is developed on the knife-sealing edge ensuring very tight and reliable vacuum seals, even under the most severe temperature applications.

Control Console: The primary user interface to the QualiTorr Remote system consisting of the color monitor, disk drives, key pad, graphics board, CPU board, power and bias supplies, analog I/O board, and analog control board. The control console connects to the RF generator module by interconnect cable.

Cursor: A highlighted area of the display that indicates opportunities to transfer data from one location on a disk to another, from one disk to another, or to remove data entirely from either of the disks. The cursor is moved by using up and down keys on the control console.

Data Disk: A formatted, double-sided, double-density, 3.5-inch floppy disk that is inserted and removed from the external disk drive located behind the front access door for the purposes of reading and writing process information.

Default Parameter: The value or selection that will be assumed by the computer if no other entry is made by the user.

Detection: The measurement of ions by the use of a sensor. The electron multiplier and BAG detect ions and have their respective outputs amplified.

Dynamic Compare (Local Mode): A function of the Run-Compare Mode that allows the comparison of data that have previously been dynamically collected (over a period of time) and data from a current dynamic data collection.

Dynamic: A file type providing graphical display of partial pressures of up to ten gases to produce process histograms of the variable vs. time from one minute to 1000 hours.

Dynamic Data: Data stored and displayed as a function of time.

Dynamic Display: The display of dynamic data using time as the X axis and amplitude of the parameter of interest as the Y axis.

Dynamic Scan: The accumulation of process parameter data over a length of time. A pre-selected choice of gases monitored in the system over a period of time to evaluate changes in the composition of the chamber environment during an portion of a process run, the complete process run, or multiple process runs. .

Electron Energy: The kinetic energy of the ionizing electrons. The negatively charged ionizing electrons are emitted from the filament and accelerated by their attraction to the positively charged grid and their repulsion from the negatively charged reflector. The electron energy is given by the relationship $E=1/2\ mv^2$, where m is the mass of the electron and v is its velocity.

Electron Multiplier Gain: The gain in current produced by the electron multiplier detector in the quadrupole probe. The gain is defined as current output/current input.

Electron Multiplier Voltage: The total electron accelerating voltage across the multiple dynodes of the electron multiplier detector. The accelerating voltage across individual dynodes is set by the use of series voltage dropping resistors.

Electron Multiplier: An ion detector with multiple amplification stage dynodes. The ions selected by the quadrupole mass filter located in the probe enter the electron multiplier and impact on the first dynode and cause electrons to be emitted. Subsequent dynode stages further amplify the electron cascade until the electrons emitted by the last dynode impact the electron multiplier anode. This signal is then amplified and sent to the control console for processing.

Filaments: Two filaments are mounted in the ionizer section of the probe. Electrons from the filaments are accelerated by the positive grid, repelled by the negative reflector, and ionize the process gas sample as it enters the probe. The filaments are made of tungsten. In special cases thoriated iridium filaments can be provided. Filaments must be replaced when they fail; this is accomplished by removing the probe and then the reflector that holds the filaments on the ion source assembly.

File: A prepared and stored process procedure for a particular process machine. The Learn function allows the user to store both Static Scans and Dynamic Scans for later use in the Run-Compare mode. Files may all contain different data or they may all be identical or variations thereof. Files are usually prepared by the process engineer and contain reference data (recipe) that are collected, stored, and retrieved for future use.

Filtering: See **Mass Filtering**.

Focus Voltage: The negative voltage that accelerates the ionized sample as it moves through the ionizer to enter the mass filter stage.

Fore Pump: See **Roughing Pump**.

Ion Energy: The kinetic energy of the ionized sample gas as it enters the quadrupole mass filter. The sample molecules and atoms are positively ionized by the accelerated electrons from the filaments in the probe's ionizer section and accelerated by the negative charge on the Focus Plate and the voltage (ion energy) applied to the grid. The ion energy is given by the relationship $E=1/2\ mv^2$, where m is the mass of the ion, v is its velocity, and E is the applied voltage.

Ion: An atom or molecule that has become either positively or negatively charged by the gain or loss of electrons. The sampled gases that enter the ionizer collide with accelerated electrons from the filaments, lose an electron (usually one per atom or molecule), and become positive ions.

Ionization: The process of ion formation. See **Ion**.

Ionizer: The section of the probe in which electrons are emitted from the filaments and are accelerated into the sample gaseous elements and molecules to positively ionize them. The ionized sample is then accelerated while passing through the ionizer and directed toward the quadrupole mass filter by the Focus Plate.

Keyswitch: The user may select between the three top level menus of the QualiTorr Remote system software by setting the two-position Run/Program keyswitch. The Run position is also chosen for taking new data and/or comparing it to previously taken information. Turning the Keyswitch clockwise beyond the Program position starts the "boot" process.

Leak Hunt: The leak hunt function tracks the pressure of the tracer gas that has leaked into the vacuum system following the application of the tracer gas to the outside of the vacuum system. The hand-held, remote control, Leak Hunter accessory is optionally available for use in this mode of operation.

LED: Abbreviation for Light Emitting Diode, a type of lamp used for displaying information and system states. Several LEDs are used in the QualiTorr Remote. These are located on the Control Board. See Figure 6-4.

Mass Filter: The rod section of the probe between the ionizer and the electron multiplier that selectively allows only ions having a specific mass-to-charge-ratio (m/e) to pass through to the electron multiplier.

Mass Location: The location on a mass spectrum that corresponds to the correct AMU of the gas that has been analyzed. For example, the correct mass location for helium is at 4 AMU.

Mass Resolution: The ability to resolve a mass spectrum into its individual component peaks. A measure of the ion-separating ability of a mass spectrometer. It is given by the peak width ΔM at a given mass M.

Millibar: A unit of pressure equal to 10^{-3} bar, 9.87 x 10^{-4} Atm, 0.75 Torr, 100 Pascal, and 750 Micron.

Overpressure: Excessive pressure in the QualiTorr Remote probe caused by excessive pressure in the process chamber, the use of the wrong pressure-reduction orifice, or the loss of system vacuum.

Partial Pressure: In a mixture of gases, each component gas exerts the same pressure, its partial pressure, as it would if it were alone and occupied the same volume. The sum of the partial pressures is the total pressure. P(total) = P_1 + P_2 + P_3 + ..., where P_1, P_2, and P_3 are the partial pressures of the component gases.

Pressure: The force per unit area exerted by gas molecules impacting on a surface. The international system of units for pressure is the Pascal. Other common units are the Atmosphere, Torr, Bar, and Millibar.

Pascal: A unit of pressure equal to 9.87 x 10^{-6} Atm, 7.5 x 10^{-3} Torr, 10^{-2} Millibar, and 7.5 Micron.

Peak Location Calibration: The adjustment of the QualiTorr Remote so that the known peaks in the mass spectrum (1 to 200 AMU) correspond to their respective AMU location on the console screen. For example, the mass peak for helium should appear at 4 AMU, not at 5 AMU or 3.5 AMU.

Peak Location: The relationship of the center of a specific peak to the AMU scale. For example, the peak location for helium should be at 4 AMU, as indicated on the console display. Proper peak location is essential for accurate peak height determination, as in Static Scan or the SPM modes of operation.

Pneumatic Multiplier: Pneumatic valves require a nitrogen pressure at 110 to 120 psi in order to activate. A nitrogen source with pressure of 60 to 80 psi can be increased to the required 110 to 120 psi pressure by the use of the optional UTI Pneumatic Multiplier.

PPM: Abbreviation for the concentration term *parts-per-million*, corresponding to a concentration of one specific type of atom or molecule in an environment of a million other atoms or molecules. The PPM is often calculated by dividing the partial pressure of the gas of interest by the total pressure (the sum of all of the partial pressures of the gases in the system) and multiplying by 10^6. For example, a helium partial pressure of 10^{-3} Torr in a process chamber at a total pressure of 10 Torr has a concentration of 100 PPM of helium.

Probe: The component in the system that ionizes the process gases, selects the sample gas ions having the desired mass-to-charge ratio, and outputs a signal proportional to the amount of the specific mass selected. The three sections of the probe consist of the ionizer, mass filter (rods), and the electron multiplier.

Probe No.: The Probe Number is the same as the Station Number. All data taken with the QualiTorr Remote is categorized for a particular probe. When more than one probe is used with one console, data from each probe must be identified with the correct Station Probe number (1-8). When the Station Controller is run in Host Computer Mode, the Station Controller's floppy disk's label designates the Station (Probe) number. See **Station Probe.**

Process Engineer: The person that is responsible for the performance and quality of a specific chemical process. This person uses the QualiTorr Remote to monitor the process and to ensure that the chemical environment of the process is optimum and that the process is performed with a high degree of reproducibility. This person is also responsible for all programming on the QualiTorr Remote.

Program: Select Probe, Calibrate, Leak Hunt, Utilities, Setup Recipes, and the Save Table functions. These functions are typically programmed by the Process Programmer.

Programmable Scan: A utility function that allows the user to continuously scan a mass region centered about a specified AMU value. This type of scan is invaluable for showing peak quality characteristics, such as resolution and mass location. In this context, a Programmable Scan is the same as an Analog Scan.

Programmer's Key: This key allows the user access to the top level menus of the QualiTorr Remote system. The main menus are the Program Menu and the Run menu.

Quadrupole: A specific type of mass spectrometer that applies RF and DC voltages to a configuration of four (quad) rods (poles) to provide a mass filter that selects ions having a specific mass-to-charge ratio. Voltages are applied in a ramp fashion to provide a scan of peaks as a function of AMU.

Raw Data: A newly collected pressure spectrum.

Ref Data: A short version of *Reference Data*, data that has been previously gathered and stored for future reference.

Reference: See **Ref Data**.

RF Generator: A component physically attached to the sensing probe flange and connected to the control console by an interconnect cable. It provides a maximum of approximately 1500 VAC at 1.6 MHz of radio frequency power to the rods to cause the filtering action on the ions that are caught in the quadrupole field.

Roughing Pump: A mechanical device used to reduce the pressure in a closed volume. A roughing pump with an ultimate vacuum capability on the order of 10^{-3} Torr is used on the output side of the turbomolecular pump when a gas sampling system is used with the QualiTorr Remote. Synonymous with **Fore Pump** in this application.

Run (Local Mode): Run mode allows the user to use the Select Probe, Run, Run Compare, and View functions. This mode is usually selected by the Process Operator.

Run (Host Computer Mode): Run mode allows the user to start a scan from the Host Computer.

Run-Compare (Local Mode): This function displays the data taken during a current run , and compares it to a previously stored run (taken in Program Mode). The data available for viewing include the *Reference* data which was learned at an earlier time plus the *Raw* data taken in the current run. These two data sets may be Compared by pressing the "Run Compare" switch to see the ratio of the *Raw* data divided by the *Reference* data, and displayed as ratios ranging from 10X to 0.1X. If all data from both *Reference* and *Raw* are exactly equal, all Compare data will lie along the 1X line of the display. This function is used for viewing data taken in both Dynamic and STATIC SCAN modes.

RS-232: A serial interface protocol used for communication between computers and peripherals.

Sensitivity Coefficient: Conversion factors for each AMU that relate the relative pressure of a mass peak as measured at the probe to the actual pressure that is present in the process chamber being monitored. A set of sensitivity coefficients has been determined for the testing configuration at the factory and is stored on the hard drive. A new set of sensitivity coefficients may be determined using the Calibrate function to ensure that the partial pressure data displayed on the console is a true quantitative measure of the partial pressures that exist in the process chamber.

SPM: Abbreviation for **Selected Peak Monitor**. This is synonomous with Dynamic Scan.

Static Scan: A mass spectrum of all of the gases in the system is completed in about 45 seconds. Each AMU location over the 1 to 200 AMU range is retrieved from the calibration table and its peak amplitude, if any, is sampled, stored, and displayed. When the scan has completed, the QualiTorr Remote determines the ten highest amplitude peaks and suggests a formula for each one.

Station Controller: The QualiTorr Remote component that contains the power supplies, amplifiers, and data processing equipment necessary to operate one Station Probe. Data from up to eight Station Controllers can be monitored and controlled by a single Host Computer over a RS-485 communications network.

Station Probe: Each QualiTorr Remote Station consists of a Station Controller and a Station Probe. Each Remote Station is numbered (1-8). Each Station Probe has its own unique associated calibration data for an open or closed ion source. A Station Probe with a closed ion source also has sampling hardware to properly condition the operating gas pressure.

Threshold: The point at which a system parameter is first measurable.

Time Profile: A Dynamic Mode display of one or more specified process gas components over a specified period of time.

TMP: Abbreviation for **Turbomolecular Pump**.

Torr: A unit of pressure equal to 1.32×10^{-3} Atm, 1.33 Millibar, and 133 Pascal. One Torr is equivalent to 1000 microns.

Tracer Gas: A gas used during leak detection to trace the location of a vacuum leak. The tracer gas is applied to localized or suspect regions on the outside of the vacuum system. If the tracer gas is detected at the probe in the Leak Hunter Mode, the leak can be *traced* to the location where the tracer gas was applied. A tracer gas that is often used for leak detection is helium, because of its fast diffusion coefficient.

Turbomolecular Pump: A high performance vacuum pump used with a mechanical pump at its output port to achieve ultimate system pressures less than 10^{-8} Torr. These pumps use electronic controllers operating at 450 to 1500 Hz to drive the turbine blades rotating at speeds ranging from 27,000 to 90,000 RPM.

Vacuum Loss: The loss of the vacuum integrity of the system. Vacuum loss can result from a system leak from the atmosphere, an increase in the pressure in the process chamber, or any event that allows the pressure in the system to exceed the nominal operating vacuum level. When this occurs, a Protect LED is lit on the Control Board (Figure 6-3) and can be reset with the enable switch on the same board. Since this is a maintenance function, the Control Board is accessable only with the Station Controller lid removed. Reset also requires a system re-boot.

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